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WATER QUALITY INVENTORY AND MANAGEMENT PLAN

MIDDLE MISSOURI RIVER BASIN

MONTANA

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WATER QUALITY INVENTORY AND MANAGEMENT PLAN
MIDDLE MISSOURI RIVER BASIN, MONTANA

PREPARED BY
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C O N T E N T S

		Page
	LIST OF TABLES	iv
	LIST OF FIGURES	vi
	LIST OF PLATES	vi
I.	INTRODUCTION	1
II.	SUMMARY AND CONCLUSIONS	3
III.	RELATED INVESTIGATIONS AND PLANS	5
	AREAWIDE WASTE TREATMENT MANAGEMENT PLANS	5
	LEVEL B AND OTHER FEDERAL PLANS	6
IV.	BASIN PHYSICAL CHARACTERISTICS	7
	CLIMATE	8
	HYDROGEOLOGY	11
	POPULATION AND ECONOMY	14
	SOILS	18
	LAND USE	20
	WATER USE	20
V.	MONTANA WATER POLLUTION CONTROL PROGRAM	21
	STATE AND FEDERAL WASTE DISCHARGE PERMIT PROGRAM	21
	WATER QUALITY STANDARDS	24
	STATEWIDE MONITORING AND SURVEILLANCE PROGRAM	25
	FACILITIES CONSTRUCTION, OPERATION, AND MAINTENANCE	25
	PUBLIC PARTICIPATION	26
	ENFORCEMENT	27

Page

VI. SURFACE WATER RESOURCES 28

VII. WATER POLLUTION POINT SOURCES 32

MUNICIPAL DISCHARGES 32

STANFORD 32

DENTON 32

LEWISTOWN 32

HOBSON 32

WINIFRED..... 32

FORT PECK POWERHOUSE 33

INDUSTRIAL FACILITIES 33

U. S. GYPSUM 33

CMSTP&P RAILROAD 34

AGRICULTURAL FACILITIES 34

VIII. NON-POINT SOURCES..... 36

IX. WATER QUALITY 40

MISSOURI RIVER 40

JUDITH RIVER 40

ARROW CREEK 41

WARM SPRING CREEK 41

BIG SPRING CREEK 41

BEAVER,BOYD, CASINO AND COTTONWOOD CREEKS 42

ROSS FORK CREEK..... 43

SAGE CREEK 43

LITTLE TROUT CREEK 43

LITTLE ROCK CREEK 62

Page

WOLF CREEK.....62

DRY WOLF CREEK.....62

BIG DRY CREEK & COFFEE CREEK.....62

X. BIOLOGICAL CONDITIONS.....66

XI. WASTE DISCHARGE PERMITS.....71

XII. WASTE LOAD ANALYSIS.....73

XIII. MUNICIPAL FACILITY NEEDS AND INVESTMENTS.....74

XIV. MANAGEMENT STRATEGY AND PLAN.....76

XV. MONITORING AND SURVEILLANCE.....81

XVI. WATER QUALITY PROBLEMS AND FUTURE NEEDS.....86

XVII. ENERGY DEVELOPMENTS.....89

APPENDIX.....A-1

APPENDIX A. GLOSSARY.....A-2

APPENDIX B. WATER QUALITY STANDARDS.....A-3

APPENDIX C. SYSTEM FOR GEOGRAPHIC LOCATION OF FEATURES.....A-18

APPENDIX D. STATEWIDE PRIORITY LIST FOR CONSTRUCTION GRANTS PROGRAM.....A-19

APPENDIX E. PERIPHYTON ANALYSIS.....A-20

APPENDIX F. SYNOPSIS OF MIDDLE MISSOURI RIVER STATIONS.....A-22

APPENDIX G. RESERVOIRS IN THE BASIN.....A-27

APPENDIX H. MIDDLE MISSOURI BASIN IRRIGATION SYSTEMS.....A-28

REFERENCES.....A-29

LIST OF TABLES

Table		Page
1.	CONDENSED WEATHER DATA FROM CHOUTEAU COUNTY	9
2.	CONDENSED WEATHER DATA FROM JUDITH BASIN COUNTY	10
3.	MIDDLE MISSOURI BASIN COMMUNITIES OF 100 OR MORE PEOPLE	15
4.	MIDDLE MISSOURI BASIN - POPULATION AND EMPLOYMENT - HISTORICAL AND PROJECTED	16
5.	MIDDLE MISSOURI BASIN, EMPLOYMENT BY GROSS SECTORS, 1970	16
6.	LAND USE IN 1967 - FERGUS, JUDITH BASIN AND GARFIELD COUNTIES IN ACRES AND PERCENT OF TOTAL	17
7.	MISCELLANEOUS TRIBUTARY FLOW RECORDS FROM THE MIDDLE MISSOURI BASIN	30
8.	TYPICAL FLOW DATA FOR MIDDLE MISSOURI BASIN	31
9.	WATER QUALITY STATIONS LOCATED ON THE MISSOURI RIVER, 1974	44
10.	WATER QUALITY DATA FROM MIDDLE MISSOURI RIVER NEAR ZORTMAN, MT (FRED ROBINSON BRIDGE)	45
11.	SUSPENDED SEDIMENT DATA FROM MAINSTEM MISSOURI RIVER NEAR LANDUSKY	46
12.	WATER QUALITY DATA FROM THE MISSOURI RIVER AND FORT PECK RESERVOIR	47
13.	WATER QUALITY DATA FROM THE JUDITH RIVER	49
14.	MISCELLANEOUS CREEKS FLOWING INTO THE MISSOURI RIVER	50
15.	WATER QUALITY DATA FROM WASTE DISCHARGERS IN THE MIDDLE MISSOURI BASIN, 1974	51

Table		Page
16	WATER QUALITY DATA FROM ARROW CREEK NORTH OF STANFORD, MONTANA	52
17.	WATER QUALITY FROM WARM SPRING CREEK NORTH OF LEWISTOWN, 1974	53
18.	WATER QUALITY DATA FROM BIG SPRING CREEK NORTH OF LEWISTOWN, 1974	54
19.	WATER QUALITY DATA FROM BIG SPRING CREEK SOUTH OF LEWISTOWN, 1974	55
20.	BIG SPRING CREEK BELOW CASINO CREEK AT LEWISTOWN, MONTANA	56
21.	WATER QUALITY DATA FROM BEAVER CREEK NEAR LEWISTOWN, 1974	57
22.	WATER QUALITY DATA FROM MISCELLANEOUS CREEKS NEAR LEWISTOWN, 1974	58
23.	WATER QUALITY DATA FROM BIG DRY CREEK NEAR VAN NORMAN, MONTANA	59
24.	WATER QUALITY DATA FROM COTTONWOOD CREEK NEAR LEWISTOWN, 1974	60
25.	CHEMICAL ANALYSIS OF SURFACE WATER FROM NORTHERN JUDITH BASIN AND ADJACENT AREAS	61
26.	WATER QUALITY DATA FROM ROSS FORK CREEK WEST OF LEWISTOWN, 1974	63
27.	WATER QUALITY FROM WOLF CREEK NEAR STANFORD AND DENTON, MONTANA	64
28.	WATER QUALITY DATA FROM DRY WOLF CREEK NEAR DENTON, 1974	65
29.	ZOOPLANKTON ANALYSIS OF FORT PECK RESERVOIR AND BIG DRY ARM	68
30.	PERIPHYTON ANALYSIS OF SELECTED STATIONS IN THE MIDDLE MISSOURI BASIN, 1974	69
31.	MIDDLE MISSOURI WASTE DISCHARGERS LOCATION, PERMIT NUMBERS AND COMPLIANCE SCHEDULES	72
32.	MUNICIPAL SEWAGE TREATMENT NEEDS IN THE MISSOURI BASIN	75
33.	MIDDLE MISSOURI WATER QUALITY SURVEILLANCE STATIONS	80

L I S T O F F I G U R E S

No.		Page
1	SKETCH MAP OF THE MIDDLE MISSOURI RIVER BASIN SHOWING STREAMS, COMMUNITIES, AND POINT DISCHARGES	2
2	SCHEMATIC OF MAJOR STREAMS IN THE MIDDLE MISSOURI BASIN	29

L I S T O F P L A T E S

I PLAN MAP OF MIDDLE MISSOURI RIVER BASIN..... In Packet

I. INTRODUCTION

The Missouri River from near Fort Benton, Montana, to Fort Peck Dam was designated the Middle Missouri by administrators of the Montana Water Quality Bureau (Plate 1). From Fort Benton to Fort Peck Dam the river flows in an easterly direction for a distance of some 275 miles (443 km). This section of river is included as one of the 16 areas in Montana's water quality management plans.

The objectives of this report are to partially fulfill the obligations of the Federal Water Pollution Control Act Amendments of 1972 (PL 92-500). This act requests that all states write basin plans (water quality management plans) and that all point and non-point pollutional sources be identified. The Federal Water Pollution Control Act Amendments of 1972 provide that for all discharges other than publicly owned treatment works, not later than July 1, 1977, effluent limitations are to be achieved which represent application of best practicable control technology currently available. All publicly owned treatment works must achieve secondary treatment by July 1, 1977.

Compliance with PL 92-500 provides the state and the Environmental Protection Agency with needed water quality data. This data forms a basic inventory of the Middle Missouri River drainage system. Determination of natural and cultural influences on water quality in the Missouri Basin will provide a basis for maintaining and enhancing water quality and the development of a basin-wide management plan.

Updating of this report will continue in the form of a monitoring and surveillance program.

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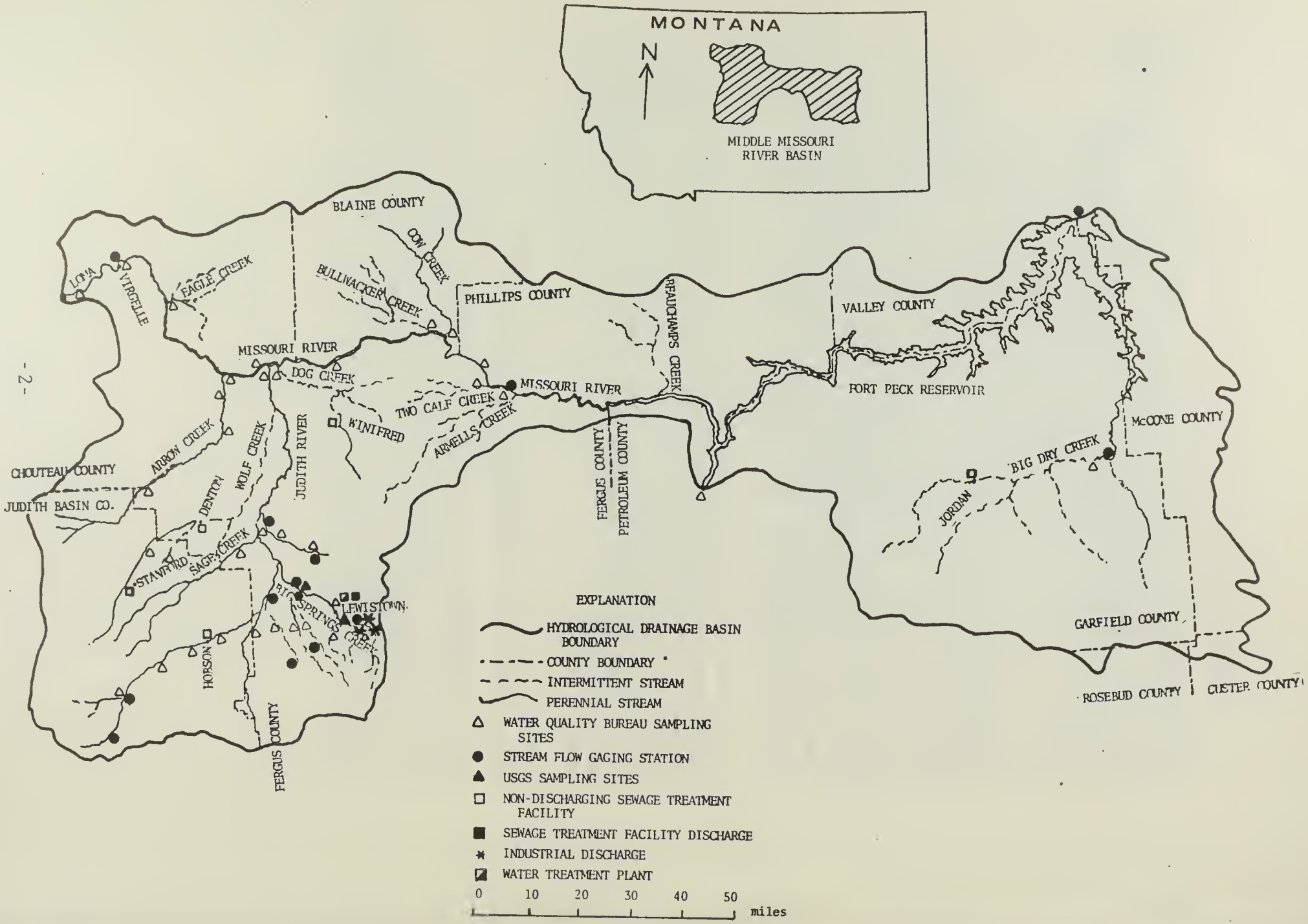
Figure 1. Sketch Map of the Middle Missouri River Basin Showing Streams, Communities and Point Discharges



II. SUMMARY AND CONCLUSIONS

The Middle Missouri Basin contains five municipal and two industrial dischargers, six known confined livestock operations, and four trout rearing sites. Non-discharging lagoons are located at Jordan, Hobson, and Winifred--the latter two lagoons act as seepage ponds. Based on an investigation of water quality in the Middle Missouri River Basin, three water quality limited segments are designated. These are:

1. Arrow Creek downstream from State Highway 230;

2. Coffee Creek; and

3. Wolf Creek downstream from Denton.

These streams are designated water quality limited due to excessive concentration of sediment and dissolved minerals that suppress aquatic biota and impares the streams' prescribed beneficial uses.

Toxic metals were not observed to be a basin water quality problem. Nutrient concentrations, particularly nitrate (NO_3) and phosphate (PO_4), observed in Beaver, Casino, Boyd, Little Trout, Cottonwood, Ross Fork, Arrow, Big Spring, Wolf, and Dry Wolf Creeks are high enough to cause serious eutrophication and depressed aquatic conditions which are present in portions of all these streams. High nutrient concentrations are caused by urban, agricultural, and natural factors. Urbanization, improper waste disposal, and refuse from Berg Sawmill affect Big Spring Creek while other streams are affected by a combination of natural and agricultural influences. Dry Wolf, Wolf, and Arrow Creeks have high concentrations of dissolved minerals probably due to agricultural practices, cultural activities, and by the area's geological setting.

In this basin, sediment is the dominant degrading water quality agent particularily in Arrow Creek, the Judith River, and the Missouri River. This pollutant emanates from irrigation returns, poor soil conservation practices, overgrazing, and natural erosion. These factors cause sedimentation in streams and destruction of the aquatic ecosystem. The erosion process also removes valuable topsoil and reduces the land's agricultural capacity. The Judith River, Arrow Creek, and the Missouri River are examples of water quality degradation caused by sediment loads. Results of this investigation indicate that non-point sources are dominant factors influencing water quality in the Middle Missouri Basin.

Additional investigations, correction or abatement of non-point pollution problems in Big Spring Creek, Arrow Creek, Judith River, and the Missouri River is recommended and additional water quality investigation should be conducted to better define water quality conditions in other streams in the basin. A summary of basin water quality problems is presented in Table 34.

III. RELATED INVESTIGATIONS AND PLANS

The Missouri River Basin Comprehensive Framework Study (1969) was concerned with guiding future planning and action in the Missouri River Basin. This study encompassed subjects from economics (Vol. 4) to management of water and related land resources (Vol. 7). This report contains no specifics for the Missouri River from Loma to Fort Peck Dam. The preceding study would be considered a level A plan.

Hatcher (1958) and Ferguson (1956) stressed the importance of water quality in the Missouri Basin. Love (1969) stated the addition of agricultural chemicals and community wastes to the Missouri River is a complex problem. Love (1969) estimated that Missouri River water will be used two to three times upon reaching its mouth. Therefore, the importance of monitoring the river for the presence of all kinds of pollutants is an important need.

Comprehensive area-wide water and sewer plans (1970) are available from Petroleum, Garfield, McCone (Vol. 10); Blaine, Phillips, Valley (Vol. 4); Chouteau, Judith Basin and Fergus (Vol. 9) Counties.

A major tributary of the Judith River (Big Spring Creek) is under a watershed work plan (1969). This watershed program is expected to alleviate silt and erosion problems on Big Spring Creek.

Water Resources surveys for Chouteau (1964) and Judith Basin (1963) Counties provides additional information as to availability of water supplies.

The U. S. Army Corps of Engineers in 1963 wrote a joint report on water and land resources for Fort Peck Reservoir to the vicinity of Fort Benton, Montana. The Corps of Engineers, Omaha District, also maintains a water quality monitoring station at Fort Peck Reservoir.

A water resources survey was conducted by Van Lewen (1971) in northeastern Garfield County. Similar surveys were conducted by Zimmerman (1960) in Blaine County and Feltis (1973) in the eastern part of Judith Basin County.

Area-Wide Waste Treatment Management Plans

Presently, Lewistown has the only 201 facility plan in preparation in the Middle Missouri basin. The intent of the plan is to arrive at the most economical and reliable wastewater treatment method for the area involved. Included in the plan will be a detailed examination of

existing growth patterns and treatment methods. The counties of Garfield and McCone have shown a considerable interest in a 208 plan. This plan would be for an area-wide land use plan to insure that the basin developments are consistent with and will not adversely effect water quality in the basin. Considerable energy development is expected in the basin particularly coal mining and coal conversion.

Level B Plans and Other Federal Plans

By definition of U. S. Water Resources Council (1970) the water quality management plan for the Middle Missouri may be considered a level B plan. This basin management plan partially fulfills the step between framework and implementation studies.

IV. GENERAL BASIN CHARACTERISTICS

The Middle Missouri River flows through Chouteau County and acts as the southern boundary of Blaine, Phillips, and Valley Counties and the northern boundary of Fergus, Petroleum, and Garfield Counties. The drainage area as listed at Fort Peck Dam is 57,556 square miles (149,070 square km) of which 23,200 square miles are in the Middle Missouri River drainage.

The terrain varies from a badland type to smoothly rolling plains. No mountainous areas fringe the Middle Missouri River. Glaciation affected the northern portion of the basin. This type of terrain is particularly suited for cattle grazing and wheat farming. These agricultural practices form the dominant land use in the Middle Missouri River Basin.

The Judith River originates in the Little Belt and Big Snowy Mountains. This river drains approximately 900 square miles (2,233 square km) and is one of two major tributaries of the Middle Missouri Basin. The Judith flows northward through Judith Basin and Fergus Counties. These two counties are agricultural economies and depend heavily on water from this basin.

The Middle Missouri River Basin from Rainbow Dam (near Great Falls) to the North Dakota state line is classified as a B-D_3 stream. Exceptions to this classification are listed in the Montana Water Quality Standards. This B-D_3 classification states: "The water quality must be maintained suitable for drinking, culinary, and food processing purposes after adequate treatment equal to coagulation, sedimentation, filtration, disinfection and any additional treatment necessary to remove naturally present impurities; bathing, swimming and recreation; growth and propagation of non-salmonid fishes and associated aquatic life, waterfowl, and furbearers and agricultural and industrial water supply."

The Judith River is classified as a B-D_1, exceptions are: Big Spring Creek from the Mill Ditch headgate to the Judith River and Judith mainstem from Big Spring Creek to the Missouri River. These segments are B-D_2. Both of these classifications call for propagation to marginal propagation of salmonid fishes. Further explanation of the classifications may be found on pages A8 and A9 of the Montana Water Quality Standards (Appendix B).

Except for Big Spring Creek area no other area in this basin has received funding for problem corrections.

Climate

The Missouri, or central basin, is typified by low annual rainfall and temperature extremes. Mean precipitation values range from 14.99 in/year (37.5 cm) to 11.52 in/year (28.8 cm). The mean annual temperatures range from 43.0°F (6.1°C) to 44.9°F (7.1°C).

June is typically the wettest month of the year. The coldest and warmest temperatures are recorded in December and July, respectively.

The following tables (1 and 2) are examples of climatological conditions in the Middle Missouri Basin. Further climatic data may be obtained from the National Oceanic and Atmospheric Administration (NOAA), Environmental Data Service, U. S. Department of Commerce.

Table 1
CONDENSED WEATHER DATA FOR CHOUTEAU COUNTY

TEMPERATURE

Station	Highest of Record	Lowest of Record	January Average	July Average	Annual Average
Big Sandy (1922-1962)	111	-52	16.2*	71.3*	44.1*
Brady (Aznoe) (1951-62)	110	-45	19.7	66.3	43.2
Ft. Benton (1938-62)	109	-46	20.8	70.2	46.0
Geraldine (1951-62)	108	-41	21.7	68.1	45.0
Loma (1950-62)	110	-49	14.7	70.3	----
Lonesome Lake (1948-62)	110	-51	12.8	67.5	42.7
Shonkin 7 S (1953-62)	104	-32	23.5	64.7	43.6

*1931-60

PRECIPITATION

Station	Yearly Average	Growing Season Average	% Falling in Growing Season	Wettest Year	Driest Year
Big Sandy (1922-62	12.06	9.24	77	19.39 (1932)	5.94 (1949)
Brady (Aznoe) (1951-62)	10.20	8.46	83	15.33 (1953)	6.56 (1952)
Ft. Benton (1931-62)	14.29	9.95	70	22.57 (1951)	7.89 (1952)
Geraldine (1951-62)	16.30	11.60	71	21.09 (1954)	9.39 (1952)
Highwood (1951-62)	15.11	10.96	73	19.57 (1962)	10.24 (1960)
Highwood 7 NE (1947-62)	14.93	11.42	76	21.76 (1953)	8.14 (1952)
Iliad (1940-62)	11.30	8.16	72	15.41 (1962)	5.47 (1952)
Loma (1950-62)	11.51	8.66	75	15.71 (1951)	5.64 (1952)
Lonesome Lake (1948-62)	10.98	8.18	74	15.18 (1954)	5.47 (1949)
Shonkin 7 S (1953-62)	25.90	17.88	69	33.07 (1962)	14.11 (1956)

Reference: Water Resources Survey, Chouteau County, Montana. State Engineers Office. Helena, Montana. June 1964. pp. 16.

Table 2
CONDENSED WEATHER DATA FOR JUDITH BASIN COUNTY

TEMPERATURE

Station	Highest of Record	Lowest of Record	January Average	July Average	Annual Average
King's Hill (1938-1961) (Cascade)	90	-41	16.3	56.7	34.9
Moccasin (1931-1961)	103	-48	20.8*	66.6*	42.8*
Raynesford (6/54-12/61)	104	-41	23.4	64.3	42.1
Stanford (1927-1961)	104	-44	22.1*	66.5*	43.2*
Utica (1894-1927)	108	-57	22.8	64.6	42.8

*1931-1960

PRECIPITATION

Station	Yearly Average	Growing Season Average	% Falling in Growing Season	Wettest Year	Driest Year
Hobson (1950-1961)	11.59	9.02	78	15.35 (1959)	8.74 (1956)
King's Hill (1938-1961) (Cascade)	28.72	15.09	53	38.71 (1959)	21.65 (1943)
Moccasin	13.73*	10.64*	77	23.78 (1909)	9.57 (1934)
Raynesford (6/54-12/61)	13.95	10.25	73	18.12 (1957)	9.88 (1960)
Stanford (1927-1961)	14.96*	11.19*	75	22.05 (1948)	9.64 (1936)
Utica (1894-1927)	16.42	12.22	74	24.16 (1909)	8.64 (1895)
Utica (1949-1958)	13.40	10.22	76	17.38 (1950)	9.71 (1957)

*1931-1960

Reference: Water Resources Survey, Judith Basin County, Montana. State Engineers Office. Helena, Montana. June 1963. pp. 14.

Hydrogeology

Groundwater is the most widely used source of domestic and stock water in the Middle Missouri River Basin. Groundwater is also used for public water supplies and irrigation. From the rugged mountains in the southwestern portion of the basin to the steep dissected terrain along the Missouri River breaks, there is a wide variety of geological formations ranging in age from Precambrian to Recent. The geological history of the Middle Missouri basin includes long periods of sedimentation, then erosion, regional uplifting, warping of the earth's crust, and continental glaciation. Availability and quality of groundwater is influenced by geological conditions in the basin.

Mountainous areas in the basin occur in the southwestern part of the area near Lewistown and in a small uplift near Zortman, Montana. Rocks that occur in these uplifts are primarily sedimentary in nature, but include some igneous type rocks. The sedimentary rocks range in age from Cambrian to Tertiary. There has been little development of groundwater in these areas, but the sedimentary rocks are thought to contain small to moderate quantities of water. Most of the sedimentary rocks exposed in the basin do not readily yield groundwater; however, some strata, including the Madison Limestone, Swift Sandstone, Eagle Sandstone, and the Kibby Sandstone may yield moderate amounts of well water.

Throughout the remainder of the basin, bedrock formations exposed in the area are of sedimentary origin and range in age from Cretaceous (65 to 135 million years old) to Recent (less than 20,000 years old). During much of Cretaceous time, thick sequences of marine sediments were deposited followed by deposition of thick, coal-bearing sediments during Cretaceous and Tertiary time.

Geologic formations of importance to groundwater resources of the basin are:

1. Alluvium of Recent geological age (less than 20,000 years old)

2. Glacial deposits of Pleistocene geological age (20,000 to one million years old)

3. Fort Union Formation of Tertiary age

4. Hell Creek--Fox Hills Formation and Judith River Formation of Cretaceous age.

Generally, formations underlying these water-bearing strata are not of great importance to water resources in the basin because of their great depth and uncertain water quality.

Exposed over large areas of the basin is the Bearpaw Shale of Cretaceous age. The Bearpaw consists of about 1,000 feet of dark, dense marine shale that contains virtually no usable groundwater. Shales of the Claggett Formation and the Colorado Shale are also present in the area and generally are non-water yielding except for small zones containing small amounts of poor quality water. The water-bearing formations of Cretaceous and Tertiary age generally yield small to moderate amounts of good to poor quality groundwater and are widely used as a source of stock and domestic water in the basin.

In the northern and western portions of the basin, continental glacial ice sheets advanced into the area, leaving a hetrogeneous mixture of rocks, boulders, gravels, silts and clays. These deposits range in thickness from a few feet to many tens of feet with a thicker deposit occurring in buried valleys and stream channels. The most abundant glacial material is glacial moraines (often called glacial till). The morainal deposits generally are poor sources of groundwater. Some wells in the till yield small quantities of fair to poor quality water. Outwash channel deposits created by deposition of sand and gravel from glacial meltwater streams are present in the morainal deposits. Such channels can store and yield moderate to occasionally large quantities of groundwater. Quality of water in the channel deposits tends to be much better than water from the morainal deposits.

Alluvium of Recent age is present in valley bottoms and along most stream channels in the basin. The alluvium ranges in thickness from a few feet to several tens of feet and generally yields moderate to large quantities of fair to good quality water.

Pollution of groundwater is not known to be widespread in the Middle Missouri basin. Sewage stabilization lagoons generally have seepage into the groundwater and create localized areas of groundwater pollution. There have been, however, no reported problems due to lagoon seepage for sewage lagoons in the basin. Septic tank drainfields and subsurface sewage disposal can create groundwater pollution where there are large numbers of septic tanks and individual water supplies using wells. Septic tanks are a problem along streams where the gravels are very porous allowing the septic tank wastes to enter into the streams.

To date, there have been few problems associated with septic tanks within the Middle Missouri basin; however, along Spring Creek near Lewistown, there have been reported problems with septic tank wastes entering the stream. Another groundwater pollutional problem in the Middle Missouri basin is saline seeps. Saline seeps originate when groundwater percolates through salt-laden geological materials, thereby dissolving a salt load from these materials and redepositing the salt in areas of groundwater discharge. A number of saline seep problems have been identified in the basin, particularly near the communities of Denton, Coffee Creek, and Highwood. Saline seep is a substantial problem in portions of the basin and the magnitude of this pollution problem is not fully known.

Population and Economy

This basin comprises more than half of Fergus, Garfield, and Judith Basin Counties, significant parts of Choteau, Blaine, and Phillips Counties, parts of Valley and McCone Counties, and very small parts of Petroleum, Prairie, Custer, and Rosebud Counties. For this profile, 1970 census data from county census divisions have been summed to approximate the population and employment of the basin. According to the 1970 census, population of the basin was 19,671 with 13,245 classed as rural residents, and 6,437 as urban. The census considers Lewistown the only urban area in the basin. Communities with 100 or more people are listed in Table 3, together with their 1970 populations. Table 4 contains historical and projected population and employment, and Table 5 shows 1970 basin employment by gross sectors.

Both population and employment have been generally declining since 1930. The major trend in employment is the regular and significant reduction in agricultural jobs. Even with this decline, agriculture still accounted directly for 37 percent of all jobs in 1970.

The Middle Missouri Basin does not function as an integral economic area. Although agriculture dominates the area, its complexion varies from west to east. For example, we can look at land use of Fergus and Judith Basin Counties toward the western end of the basin and Garfield toward the east. Table 6 is based on 1970 USDA conservation needs inventory.

The western area has a greater percentage of cropland; the east more range. According to USDA agricultural statistics; however, the percentage of cropland in irrigation is about the same for each county, although the western area has four to five times more total cropland. Major crops are wheat, barley, and hay. Livestock are mainly cattle and sheep with the western area dominantly producing cattle and the eastern area sheep.

The major trading center in the area is Lewistown with Great Falls and Miles City active trade centers out of the basin.

Table 3

MIDDLE MISSOURI BASIN
COMMUNITIES OF 100 OR MORE PEOPLE

COMMUNITY	COUNTY	1970 POPULATION
Denton	Fergus	398
Garneill	Fergus	110
Lewistown	Fergus	6,437
Moore	Fergus	219
Winifred	Fergus	220
Jordan	Garfield	529
Geyser	Judith Basin	142
Hobson	Judith Basin	192
Stanford	Judith Basin	505

Table 4

MIDDLE MISSOURI BASIN - POPULATION AND EMPLOYMENT - HISTORICAL AND PROJECTED

1930-1985

	1930	1940	1950	1960	1970	1980	1985
Population	29,725	23,495	22,205	22,019	19,671	18,779	18,145
Employment	11,555	8,051	8,615	7,713	7,065	6,253	5,866

Table 5

MIDDLE MISSOURI BASIN, EMPLOYMENT BY GROSS SECTORS, 1970

	Number	Percent of Total
Agriculture	2,621	37
Forestry and Fisheries	13	0*
Mining	18	0*
Construction	344	5
Manufacturing	252	4
Services and other	3,817	54
	7,065	100

*Less than one-half of one percent

Table 6

LAND USE IN 1967 - FERGUS, JUDITH BASIN AND GARFIELD COUNTIES
IN ACRES AND PERCENT OF TOTAL

	Total Inventory	Cropland	Pasture	Range	Forest	Other
Fergus	2,213,794 100%*	556,637 25%	58,000 3%	1,384,969 63%	199,772 9%	14,416 1%
Judith Basin	882,818 100%*	286,855 32%	22,250 3%	551,084 62%	18,139 2%	4,490 1%
Garfield	2,250,483 100%*	138,000 6%	40,000 2%	2,018,602 90%	41,381 2%	11,500 1%

*Do not total to 100 percent due to rounding.

Soils

The soils of the Middle Missouri River basin differ greatly in their characteristics. This variation is associated with the physical setting and climatic conditions under which they developed. The river basin occupies an area transitional between the Rocky Mountains and the vast continental slope known as the Northern Great Plains.

The mountains in the central part of the area enclose intermountain basins. Table lands occur locally on the slopes of the mountain uplifts and extend north into the glaciated plains and east into the dissected plains.

Deep, well-drained clay loam and silty clay loam soils have developed on nearly level to rolling glaciated plains. Also on the glaciated plains, deep, well-drained silt loam and silty clay loam soils have developed. Areas with wet and saline soils are found on concave positions and along drainageways. These soils of the glaciated plains have been used for dryland agriculture. Although they may present a moderate erosion hazard, the problem of saline seep is a more serious threat to water quality.

Calcareous clay soils have developed over part of the glaciated plains. Clay pan has developed on some of the low terraces and along some of the drainageways.

Soils of the high benches and piedmont fans are generally well drained loams with varying depths to the gravelly subsoil. Some of these soils have a high lime content in the subsoil. Many of the deeper soils are used for dryland agriculture. These soils present a slight to moderate erosion hazard.

Soils of the rolling residual uplands vary in depth but are generally loams, clay loams and clays. These soils can be as shallow as 20 inches or less over shales to over 50 inches over shales and to a lesser extent sandstones. Rock outcrops are common along escarpments. The deeper soils are formed, but these are generally considered grazing soils. Areas affected by salinity and alkalinity are in evidence. These soils present moderate to severe erosion hazards.

Along the major watercourses are rough, broken lands with clay soils that are less than 20 inches to shale. Numerous shale outcrops occur. These soils present a severe erosion hazard.

Soils of the steep mountainous lands vary considerably but are generally well-drained and underlain by rock at 10 to 40 inches. Some very shallow stony soils occupy steep slopes along with rock outcrops. Stony phases are common to many mountainous soils. These soils are used for timber production, forage production and recreation. They generally do not present a severe erosion hazard if under proper management.

Land Use

Based on 1967 land use data presented in the Montana Soil and Water Conservation Needs Inventory, the largest land use in the basin is privately owned range land which constitutes approximately 58% of the total land resource. Federal non-crop which includes all federal lands in the basin that are not being farmed accounts for 21.9% of the basin. It can be assumed that the majority of this is being used as range land. Other major land uses within the basin are as follows: cropland 14.0%, urban and built up area 0.7%, forest 3%, small water area under 40 acres in size 0.2%, and pasture 1.9%. The remaining 0.4% is considered as unusable and includes areas such as rock outcrops. Irrigated lands account for 48,078 acres of the basin with an additional 727,495 acres considered to be irrigable. Irrigable lands may include those presently being used for dryland crop production. Irrigated crops are primarily hay and pasture grasses, while small grains and hay are the major dryland crops in the basin.

Water Use

The largest water use in the basin is for irrigation which diverts approximately 248,000 acre feet annually. About 174,000 acre feet of this is delivered to the farm and 117,000 is consumed or lost, and a total of 131,000 acre feet is return flows. These figures are all approximate and are based on 70% delivery system efficiency and a 35% farm efficiency.

Municipal water use in the basin accounts for 2,395 acre feet annually, with eight communities served by municipal systems. All of these are dependent upon groundwater sources for supply. Nine other communities in the basin with a population of 25 or more are not served by a municipal system. It is estimated that these communities use approximately 74 acre feet of water per year.

Other water usage in the basin, i.e., industrial and stock water, is negligible.

V. MONTANA WATER POLLUTION CONTROL PROGRAM

INTRODUCTION

Water quality management planning is part of a broad, comprehensive water pollution control program administered by the Water Quality Bureau of the Environmental Sciences Division of the Montana Department of Health and Environmental Sciences. Details of this program are described in annual reports of the bureau. Important elements of the state program are:

1. State and federal waste discharge permit programs.

2. Water quality standards.

3. Statewide monitoring and surveillance.

4. Facilities construction grants, plan review, operation and maintenance inspections, training and licensing of operators.

5. Public participation.

6. Enforcement.

STATE AND FEDERAL WASTE DISCHARGE PERMIT PROGRAMS

The present state program of issuing waste discharge permits is operated under the authority given by the Montana water pollution control law and the Montana Pollutant Discharge Elimination System (MPDES). At the present time, the U. S. Environmental Protection Agency (EPA) is also issuing waste discharge permits in the state of Montana to federal facilities and to discharges, from other than incorporated communities, on Indian reservations. The permits are being issued pursuant to the National Pollutant Discharge Elimination System (NPDES) created by the Federal Water Pollution Control Act Amendments of 1972 (FWPCAA of 1972). To eliminate the duplication of effort which formerly existed, the state of Montana applied for and received authority from EPA to issue NPDES permits in Montana. Section 402

of the FWPCAA of 1972 provides that states with adequate water pollution control programs may apply for and receive authority from EPA to issue discharge permits under the NPDES in their own states. Montana made the necessary revisions to the state water pollution control laws during the 1973 legislative session to provide statutory authority for administration of the NPDES program in Montana. The Montana Department of Health and Environmental Sciences was given the authority to administer the waste discharge permit program on June 10, 1974. Waste discharge permits issued under the NPDES prior to the MPDES permit program will serve as MPDES permit until their date of expiration. All MPDES permits issued meet the minimum requirements of the EPA for NPDES permits.

The Federal Water Pollution Control Act Amendments of 1972 established the following time schedule for upgrading waste treatment facilities:

MUNICIPALITIES

1. Secondary treatment by July 1, 1977.
2. Best practical control technology by July 1, 1983.
3. No discharge of pollutants by 1985 (goal)

INDUSTRIES

1. Best practicable control technology by July 1, 1977.
2. Best available control technology by July 1, 1983.
3. No discharge of pollutants by 1985 (goal).

NATIONAL SECONDARY TREATMENT REQUIREMENTS (FWPCAA OF 1972)

Minimum five-day biochemical oxygen demand (BOD_5) reduction to 85 percent.

Minimum suspended solids reduction of 85 percent.

Maximum effluent BOD_5 of 30 mg/l on monthly average and 45 mg/l on weekly average.

Maximum effluent suspended solids of 30 mg/l on monthly average and 45 mg/l on weekly average.

Maximum effluent fecal coliform of 200 organisms/100 ml on monthly average and 400 organisms/100 ml on weekly average.

pH limits on effluent maintained between 6 and 9.

Self-monitoring of these parameters is required. The frequency of monitoring is based on the population served and the complexity of the treatment facility and is stated in the NPDES or MPDES permit. In addition, some municipal dischargers are limited for and required to monitor effluent oil and grease.

WATER TREATMENT PLANT TREATMENT REQUIREMENTS

There are no parameters specified by the FWPCAA of 1972 to be monitored for water treatment plant discharges. The following requirements are being placed on NPDES permits issued in Montana:

1. No change in operating procedures will be allowed that would result in a less desirable discharge.

2. As soon as practicable but no later than July 1, 1977:

Total suspended solids (TSS)	$<$45 mg/l weekly average $<$30 mg/l monthly average
Total dissolved aluminum	1.0 mg/l monthly average $<$1.5 mg/l grab sample
pH	Maintained between 6.0 and 9.0

INDUSTRIAL BEST PRACTICABLE CONTROL TECHNOLOGY REQUIREMENTS (FWPCAA OF 1972)

Industrial waste dischargers will be required to provide the best practicable control technology currently available in treatment of their waste discharges. The parameters will be limited and monitored, and the frequency of monitoring will vary with the different types of industries. The specific parameters to be limited and monitored and the frequency of monitoring are stated in the NPDES or MPDES permit.

AGRICULTURAL TREATMENT REQUIREMENTS (FWPCAA OF 1972)

Federal regulations require that any animal confinement facility which on any 30 days during the previous twelve months contained 1,000 or more animal units must apply for a waste discharge permit. The Montana Pollutant Discharge Elimination System Rule requires that any animal confinement facility,

without regard to size, which discharges to state waters must apply for a waste discharge permit. The following is a list of the number of animal units for those types of animal confinement facilities in or expected to be in operation in Montana:

Slaughter and Feeder Cattle	1.0 animal units/animal
Mature Dairy Cattle	1.4 animal units/animal
Swine over 55 pounds	0.4 animal units/animal
Sheep	0.1 animal units/animal
Fish (where discharge occurs on at least 30 days/year)	0.05 animal units/pound

The waste discharge permits issued for animal confinement facilities will generally prohibit any discharge of pollutants unless rainfall in excess of the 10-year/24-hour rainfall or equivalent moisture has been received.

Irrigation return flows will be subject to MPDES permit if there is a point source discharge through a man-made or man-maintained drainage system from 3,000 or more irrigated acres. The parameters to be monitored and the frequency of monitoring will be stated on the discharge permit.

WATER QUALITY STANDARDS

Water pollution control started in Montana in 1907 with passage of legislation designed to protect domestic water supplies. A more comprehensive law was passed in 1955 that dealt with control and protection of water for recreation, agriculture, and industry. The 1955 law also established a water pollution control council and charged it with the tasks of classifying all streams in the state according to their most beneficial uses and establishing water quality criteria for the streams. The 1955 law also involved upgrading the treatment of wastes going into the streams. Montana thus became one of the first states to have enforceable stream classifications.

In 1965, the U. S. Congress passed the Federal Water Quality Act which required that all states classify and

establish water quality criteria for their interstate streams by July 1, 1967. Montana revised its standards for both interstate and intrastate waters and required a higher degree of stream quality than before. Secondary treatment or the equivalent was required of municipal and industrial discharges. In October, 1972, the Federal Water Pollution Control Act Amendments were passed expanding the authority of the Environmental Protection Agency. Uniform water quality standards and enforcement procedures throughout the United States became the objective. Montana revised its water quality standards and adopted these revised standards on July 13, 1973. The new standards became effective in November, 1973.

Montana water quality standards serve as a functional tool in protecting water quality; however, a number of laws, statutes, and regulations complement the water quality standards and significantly assist in protecting water quality.

STATEWIDE MONITORING AND SURVEILLANCE PROGRAM

Prior to 1972, Montana had done little water quality monitoring due to inadequate funding. With increased appropriations provided by the 1971 legislature and the federal government, the state greatly increased its effort. Personnel were added to the staff, and laboratory capabilities were expanded. The present state monitoring program includes compliance monitoring of point sources of wastes including monitoring of municipal and industrial wastes, long-term baseline monitoring of streams, and a statewide program for determining the general quality of all significant surface waters.

The statewide inventory of water quality will identify areas with water quality problems and will provide basic data for water quality management and planning programs. Included in the monitoring is a statewide assessment of the trophic (pollution level) status of Montana's lakes, reservoirs, and ponds. This program is coordinated with the EPA National Eutrophication Survey.

FACILITIES CONSTRUCTION, OPERATION, AND MAINTENANCE

A minimum requirement of primary treatment for all domestic sewage was first adopted by the Montana Board of Health

in 1952. All of Montana's communities have met this requirement, and many of the communities are upgrading their facilities to secondary treatment or are in the process of constructing or planning secondary treatment systems. Since 1956, there has been a federal grant program to assist municipalities in the construction of sewage treatment facilities, including outfall and interceptor sewers. In 1971, the Montana state legislature appropriated $4,000,000 to aid municipalities in construction of these same facilities. The 1973 legislature appropriated $1,600,000 to reimburse municipalities that had proceeded with construction since July 1, 1966, without waiting for state grants. With passage of the Federal Water Pollution Control Act Amendments of 1972, 75 percent of eligible project costs are federally financed. Due to a shortage of federal grant funds, a priority system for allocation must be used. The state, under EPA guidance, establishes priorities for proposed waste treatment projects.

An important part of municipal sewage treatment is proper operation and maintenance of facilities after construction is completed. In an effort to improve operation and maintenance, the state has conducted an operators' school each year. During recent years, this school has had about 100 operators attending. In 1971, a grant was obtained from the federal government for employing two training instructors to establish training programs throughout the state. This activity is in addition to the annual school.

An operators certification program was established in 1968 following enactment of a law requiring certification of those responsible for the operation of sewage treatment or industrial waste treatment systems.

PUBLIC PARTICIPATION

Public participation in the water pollution control is an increasingly important aspect of the state program. Public hearings are held concerning proposed regulations, water quality management plans, and waste discharge permit applications. The state also has an environmental impact statement requirement. These statements are presented to the public for comment, and hearings are conducted on highly controversial issues.

The public also is kept informed by means of a water pollution control advisory council which has been established by law to assist the Water Quality Bureau in preparation of rules and regulations and dissemination

of information to interested groups. Similarly, public meetings are attended on request, and a quarterly newsletter is published by the Water Quality Bureau.

ENFORCEMENT

Montana's laws on water pollution basically state (1) it is unlawful to cause pollution or place materials in a location where they are likely to cause pollution of state waters, and (2) discharge of waste material into state waters without a permit from the Department of Health and Environmental Sciences. Two administrative rules have been adopted by the Board of Health and Environmental Sciences which are the chief elements in Montana's water pollution control program. Montana's water quality standards serve as the primary means for defining pollution, and the Montana Pollutant Discharge Elimination System rule provides the mechanism for authorizing and controlling point source discharges to state waters. Violators of the law, a rule, permit, or order could be subject to injunction, civil penalties up to $10,000 for each day of violation, or criminal penalties with fines not to exceed $25,000 per day of violation and/or imprisonment for not more than one year for an initial conviction and not more than $50,000 per day of violation and/or imprisonment for not more than two years for subsequent violations. Significant steps were taken in 1974 to establish a workable enforcement program, including increasing the legal staff and additional allocation of technical staff.

VI. SURFACE WATER RESOURCES

The Middle Missouri Basin contains three major sub-basins (Fig. 1, Plate I). They are the Judith River, Arrow, and Big Dry Creeks. Mainstem Missouri River is significantly regulated by eight upstream dams. Fort Peck Dam, the largest reservoir in Montana, regulates the flow of the Missouri River downstream from the Middle Missouri River Basin. Flow recording stations on the mainstem in this basin are located at 1) Virgelle, 2) near Landusky, and 3) downstream of Fort Peck Reservoir. The Fort Peck station is in the Lower Missouri River Basin, but for comparative purposes it is included in this report. The periods of available records are 1935, 1934, 1934 to the current year at the Virgelle, Landusky, and Fort Peck stations, respectively.

Peak stream flows in the Missouri River occur during the months of April through June (Table 8); this coincides with snowmelt runoff and spring precipitation. A relatively stable baseflow occurs during the fall and winter months; however, warm "chinook" winds during winter months may cause sudden flow increases. Minor tributaries such as Eagle, Bullwhacker, Big Dry, and Dog Creeks have little influence except during spring months. In these smaller drainages sudden thundershowers will cause sharp flow increases which quickly recede.

Stream flow in the Judith River drainage and Arrow Creek are influenced by spring runoff, rainfall, and irrigation diversions. Peak flows occur during the spring months of April through June. Flow records from the Judith Basin (Table 7) are scarce and there have been no permanent stream flow stations in the basin.

Big Spring and Warm Spring Creeks are perennial springs and flow rates have remained relatively constant throughout the years. Downstream flows on these streams are influenced by irrigation diversions, rainfall, and snowmelt runoff.

Minor streams such as Ross Fork, Cottonwood, Beaver, and Sage Creeks all have peak flows in the spring. Throughout the summer months their flows are erratic due to irrigation diversions and thundershower activities.

There are a large number of smaller drainages in the basin that are drained by small ephemeral streams. These streams flow only in response to periods of snowmelt or rainfall.

Figure 2

Schematic of Major Streams in the Middle Missouri Basin.

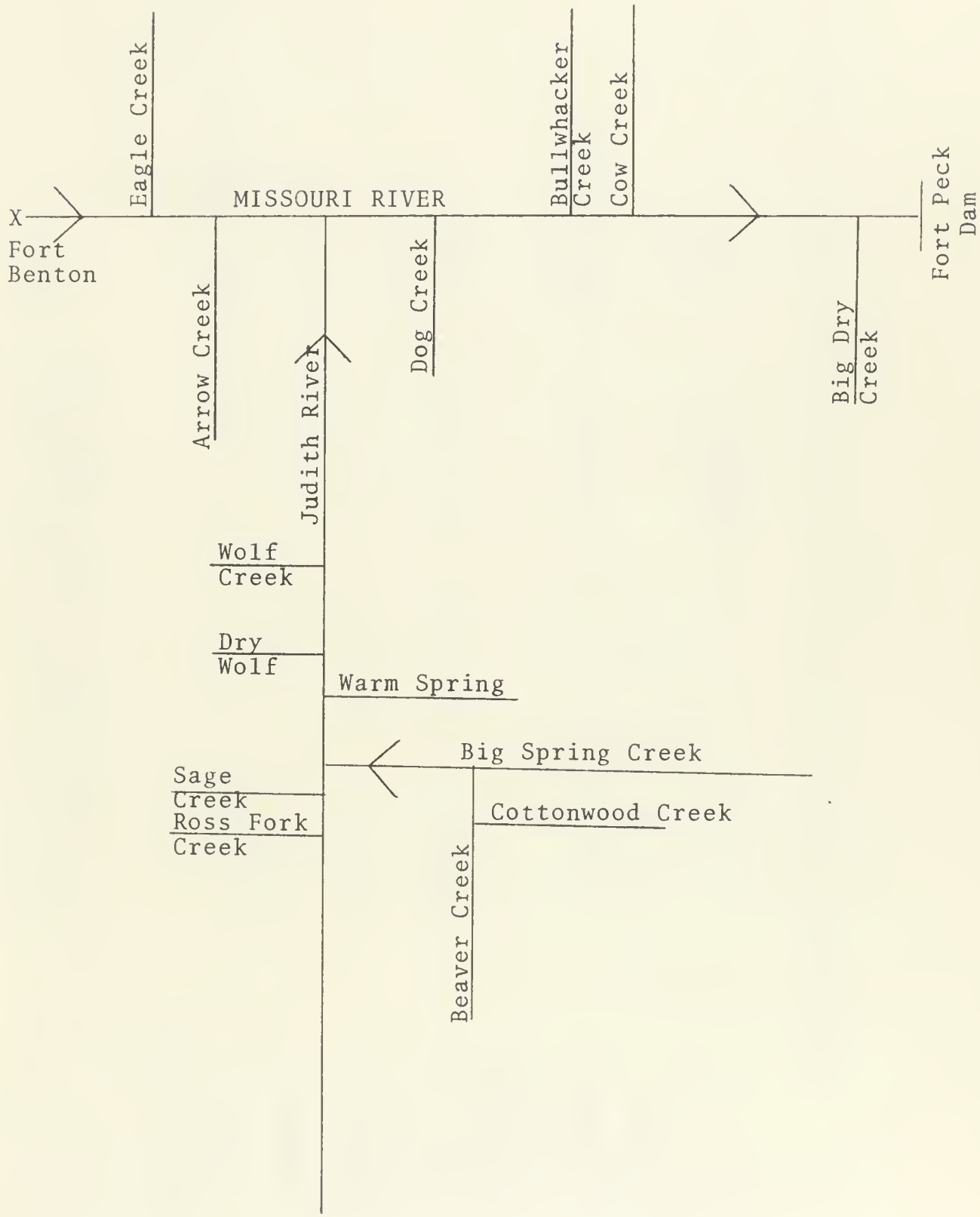


Table 7

MISCELLANEOUS TRIBUTARY FLOW RECORDS FROM THE MIDDLE MISSOURI RIVER BASIN

STATION	LOCATION	PERIOD OF RECORD	DATE	RECORDED (cfs)
Judith River tributary	10 miles SW of Utica 13N 11E 13	1960-1972	3/16/72	30
South Fork Judith River	12N 11E 23CC		5/24/72	150
South Fork Judith River	13N 11E 36D		5/31/72	83.4
Casino Creek tributary	5 miles S of Lewistown 14N 18E 09	1960-1972	3/18/72	5
Missouri River tributary	19 miles S of Landusky 22N 24E 31	1962-1972	6/9/72	1950
Duval Creek	11 miles SW of Landusky @ Hwy 191 23N 23E 13	1963-1972	6/9/72	340
Wolf Creek previous years 1919-26, 1927-28	16N 11E 26D		10/20/71	4.43 est.

Reference - USGS Surface Water Resources for Montana, 1972.

Table 8
Typical Flow Data for Middle Missouri Basin
Monthly Mean Discharge (cfs x 10^3)
Water Year Oct 1972 - Sept 1973

STATION	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SPT	1972 AVERAGE DISCHARGE	AVERAGE DISCHARGE FOR PERIOD OF RECORD
Virgelle	8.7	7.9	7.2	6.9	7.2	5.6	5.3	6.9	7.6	6.4	4.8	4.4	6.6	8.3
Landusky	8.9	8.3	6.9	7.0	7.2	6.5	5.8	7.5	8.2	6.5	5.0	4.7	6.9	9.0
Downstream of Fort Peck Reservoir	8.5	9.0	10.8	11.1	13.7	13.3	7.6	6.2	6.2	6.7	7.7	6.8	8.9	8.9

Stations listed are located sequentially downstream on mainstem Missouri.

Reference: USGS Water Resources Data, 1973.

VII. WATER POLLUTION POINT SOURCES

Chemical parameters and locations of known waste dischargers are presented in Table 15. At present no known mineral excavations or explorations are affecting water quality in this basin. Isolated gravel excavations are exceptions.

MUNICIPAL DISCHARGES

Stanford

A single-cell, six-acre lagoon with a normal operating depth of 5 feet provides sewage treatment. Intermittent overflow is discharged to a tributary of Coyote Creek. Effluent discharged from this lagoon probably does not meet national secondary treatment standards. Design population equivalent for the lagoon is 600 persons; present sewered population is estimated at 500 persons. Infiltration is not a problem.

Denton

A single-cell, 4.8-acre lagoon with a normal operating depth of 5 feet provides sewage treatment. Effluent discharged continuously to Running Wolf Creek probably does not meet national secondary treatment standards. Design population equivalent for the lagoon is 480 persons; present sewered population is estimated at 250 persons. Infiltration has not been reported as a problem.

Lewistown

Sewage treatment is provided by a 2 mgd (million gallon per day) primary treatment plant constructed in 1965. Unit processes consist of communitation, grit removal, primary clarification, sludge digestion and chlorination. Final effluent is discharged to Big Spring Creek. Secondary treatment is needed to meet national secondary treatment standards. Estimated sewered population is 6400 persons. At least 50% of the total flow in the spring is attributed to infiltration. The problem generally persists throughout the summer due to high groundwater levels. Storm water input from roof leaders and surcharged manhole covers in the downtown area are also a problem, necessitating improvements .

Hobson

A two-cell, 0.5 acre each parallel operated lagoon system with a maximum design operating depth of 3 feet provides sewage treatment. However, design deficiencies preclude proper operation. Gradient of the outfall line is insufficient to prevent solids deposition in the line; at design depth, the manhole which regulates flow to each cell, is surcharged. During summer months, water is pumped from the lagoon to irrigate adjacent pasture. This keeps water levels in the cells below that which surcharges the manholes. Operating depth for the cells is maintained at about one foot during winter months. Effluent ponds in a swale between the highway

and railroad before draining under the roadbed and onto adjacent pasture where the effluent eventually seeps into the ground. The effluent does not discharge to a defined drainageway nor does it reach any surface waters. Design population equivalent for the system is 100 persons; estimated population served is 150 persons plus 100 school children (from outside the town). Infiltration is a problem during the summer irrigation season. This system cannot meet national secondary treatment standards and will have to be upgraded.

Winifred

A single-cell, one-acre lagoon with an estimated maximum design depth of 5 feet provides sewage treatment. There is no overflow from the discharge structure; however, significant seepage occurs along the north dike. This seepage reaches Dog Creek via a former stream meander. If seepage is minimized, a discharge from the overflow structure may occur. Effluent from such a discharge probably would not meet national secondary treatment standards. Design population equivalent for the system is 100 persons; estimated population served is 75 plus school children from surrounding area.

Fort Peck Powerhouse

The powerhouse is staffed by a small crew. Sewage treatment is provided by an extended aeration plant. Effluent is meeting national secondary treatment standards.

INDUSTRIAL FACILITIES

U. S. Gypsum

The U. S. Gypsum plant is about nine miles southeast of Lewistown near Heath, Montana. As part of the mine operation a conveyor system passes through an inactive mine area. A continuous, but variable flow of groundwater enters one area of the conveyor system floor and the water is removed by a sump pump. The water is discharged to an unnamed coulee then flows to a marshy area adjacent to the East Fork of Big Spring Creek. Characteristics of the discharge are:

Flow	26,000 gpd (Min.)
	5,000 gpd (Ave.)
	172,800 gpd (Max.)
Temperature	42° F.
Specific Conductance	1,900 µmhos km
Total Suspended Solids	3.6 mg/l

CMSTP&P Railroad

The Chicago, Milwaukee, St. Paul and Pacific railroad discharges wastes from engine washing and maintenance servicing facilities in Lewistown, Montana. The wastes are processed through a oil/solids separator system equipped with a belt type oil skimmer, peripheral surface skimmer and an oil storage tank. The treated wastes are discharged to an open ditch that flows into Big Spring Creek. Characteristics of the waste are:

Flow	8,500 to 10,500 gpd
pH	6.0 - 7.0
Temperature	50 - 70° F.
Oil and Grease	2 - 10 mg/1
Total Suspended Solids	15 mg/1
Total Dissolved Solids	944 mg/1

AGRICULTURAL FACILITIES

Six facilities have applied for or have received discharge permits (Table 31). There are six more confined livestock facilities that have not applied for discharge permits.

Problems related to agriculture have been identified in the following streams: Sage Creek, nitrate (30 mg/1); Cottonwood Creek, nitrate (8.9, 11.0 mg/1); Ross Fork, nitrate (11.0, 13.0 mg/1), excessive BOD_5, high coliform count; and Beaver Creek, high nitrate (7.1 mg/1). High coliform count was observed on the Judith River between Hobson and Utica and at the river's mouth (Tables 13, 22). These problems are assumed to be agriculturally related since there are no other possible sources.

Further investigation is needed in these streams to determine the source of these contaminants. Silt problems from agricultural or other activities are discussed in Section VIII.

L. R. Ranch Company. This facility has capacity for 1500 head of cattle and swine. A discharge should not occur at this facility. Approximately 16,000 acres of land are available for waste disposal.

Peterson Ranch. This facility has capacity for 2200 head of cattle. A retention facility should provide sufficient capacity to contain runoff from a 10-year, 24-hour rainfall or equivalent. Approximately 3,000 acres of land are available for waste disposal.

Peterson Ranch and Feedlot. This facility has a capacity for approximately 1000 head. Runoff is contained by two retention ponds that should provide sufficient capacity to contain runoff from a 10-year, 24-hour rainfall or equivalent. Approximately 3000 acres of land are available for waste disposal.

Tadej Ranch Company. This facility has a capacity for approximately 1100 animals. Chances are remote for runoff reaching state waters. Approximately 2400 acres are available for waste disposal.

Miscellaneous

(1) An undetermined number of septic tanks discharge to Big Spring Creek.

(2) King Colony Ranch sewage discharge to Ross Fork Creek or unnamed arm.

(3) Lewistown swimming pool discharges filter washings and chlorinated water to Big Spring Creek.

(4) Mill Creek diversion dam causes silt accumulation, which is later flushed into Big Spring Creek.

VIII. NON-POINT SOURCES

Ecological impact of non-point sources depends on intensity and yield factors as well as on the seasonal distribution of their contribution. Since overland flow and stream flow are the major transport agents for the non-point sources, knowledge of time changes in concentration and flow are essential for calculations of yield rates. Comparison of non-point sources based solely on concentration units is difficult because of the flow-dependent, intermittent nature of the sources. A better method of comparison is the use of area yield rates. A commonly used yield rate is the quantity of characteristic (e.g., sediment) per unit of drainage area per unit of rainfall or runoff (Loehr, 1974).

Non-point sources in the Middle Missouri fall into four broad categories: logging, agricultural, urbanization (e.g., Big Spring Creek area), and natural (e.g., Arrow Creek). Silt is a common pollutant shared by all of the aforementioned. Heavy silt loads decrease or destroy a stream's natural productivity and aesthetic value. These silt loads are often associated with higher water temperatures, increased turbidities, low oxygen levels, increased nutrient loads, and ultimate destruction of the aquatic biota. A Corps of Engineers (1963) report lists erosion in this basin as a result of historic land use practices, fire, and improper distribution of livestock and wildlife as caused by man.

Logging and associated road work in areas adjacent to or headwater areas of the Judith River and Big Spring Creek drainages act as a detriment to water quality. Studies by Burns (1972) showed that oxygen dropped to 5 parts per million in some isolated pools while temperatures, turbidities, and flows increased. Hall and Lantz (1969) and Lantz (1971) have presented data showing extreme temperature and oxygen fluctuations in logged areas. In a deforested area, Hobbie and Likens (1973) showed increased erosion, flow, phosphorus, and organic carbon values. Further work is needed in these basins to determine if Montana water quality laws are being violated. If similar fluctuations are occurring in the Judith Basin, then temperature, oxygen and turbidity requirements of a B-D_1 stream are not being met.

Protection of stream beds in forest areas is needed as water draining from essentially undisturbed forests sets a baseline for water quality. Cooper (1969) states that forest cover regulates nutrient output by both storing

nutrients in standing vegetation and influences the flow of water through the soil profile. From the standpoint of water quality protection, it should be imperative that forested areas adjacent to streams be protected.

Agricultural practices that cause silt*loads emanate from the following: irrigation, overgrazing, extensive monoculture, and removal of brush and trees from stream banks. The first three items would be the dominant factors in the Middle Missouri Basin. Other agricultural pollutants may arise from concentrated feed operations, sprays and fertilizers. With the few feedlots located in this basin one would not expect any stream problem caused by feedlot runoff; there are exceptions (e.g., Ross Fork Creek). Furthermore, it should be noted that yields of nitrogen and phosphorus in animal feedlot runoff are orders of magnitude greater than those of other non-point sources (Loehr, 1974).

Data for irrigated acreage is incomplete for the Middle Missouri. However, Chouteau and Judith Basin Counties list 13,000 and 18,862 acres presently under irrigation (Montana Water Resources Survey, Judith Basin 1963 and Chouteau 1964). Immediate factors affecting a stream that is used for irrigation are: temperature increases, silt loads, and dewatering. All of the proceding are harmful in sustaining a cold water fishery and in maintaining water quality. Irrigation return flow often carries excessive salts which are washed off fields. The quality of return flow is affected by a multitude of factors: evaporation, transpiration, ion exchange, erosion, composition of the soil, types of crops, fertilizers, and precipitation--amount and rate. Irrigation return waters may be improved by settling basins or by the prevention of excessive amounts of water reaching the irrigated plots. The latter would require metered canals and only use of water needed. Present systems employed in this basin encourage waste and abuse of the water resources. Irrigation return flow effects may further be alleviated by encouraging ground cover, prevention of stream bank defoliation.

Extensive monoculture and overgrazing result in removal of protective vegetation. This loss of vegetation results in greater soil erosion which in turn results in heavier silt loads to streams. As noted by Loehr (1974), wide ranges of phosphorous values are given from runoff. These ranges are variable due to erosion; when erosion is controlled, the total phosphorous load should decline.

*Silt and sediment are used interchangeably in this report.

Arrow Creek is the major natural non-point source in the Middle Missouri Basin. The vegetation in Arrow Creek varies from poor to good grassland to sagebrush. Since this basin is essentially alluvial plain, it is subject to natural erosion. Silt load emanating from Arrow Creek on July 9, 1974, was measured at 6.9×10^4 tons/day (Table 16). During this time period, this load was 41 percent of the total load measured in the Missouri River (Table 9). Three other creeks plus Arrow Creek accounted for 73 percent of the total load in this section of the Missouri River (Table 14).

Several alternatives are available in nullifying this non-point source. Where feasible, such structures as check dams, berms, gabions, or sediment retention basins should be established. Vegetation growth should be strongly encouraged as vegetation dissipates erosive energy from falling rain and roots help hold the soil in place. In areas where highway building has influenced erosion, concrete chutes, diversions, and terracing are some of the methods that may be employed in controlling this silt source.

Silt sources to Big Spring Creek result from urbanization and its associated removal of vegetation and uncontrolled floodplain construction. One source that may be easily controlled is the Mill Creek diversion channel. When the diversion gates are closed, a silt build-up results. Subsequently, when the gates are reopened, large amounts of silt are released to Big Spring Creek. Avoidance of the problem can be accomplished by maintaining a flow through the diversion gates.

Saline seep is another non-point source in this basin which needs attention. The magnitude of the problem is not completely documented. However, the potential for degrading water quality and water supplies is tremendous. Work presently under progress in this field is in its infancy and should be further explored. Estimated state-wide affected acreage is placed at 260,000 acres. Streams reflecting saline problems are Sage, Big Dry, Dry Wolf, Dog, Bullwhacker, Two Calf, Wolf, and Arrow Creeks. Values depicting severity of salinity are found on Tables 14, 16, 25, 27, & 28. A more thorough discussion of this problem is presented by Bahls and Miller (1973).

Precipitation may act as a non-point source if the air contains many particulates. However, with no heavy industry in this basin, precipitation as a non-point source is not a problem.

Stumm (1970) points out that non-point source control is basically a conflict between resource exploitation and protection of natural waters. Stumm breaks the conflict

into two groups: reducing ecological stability and promoting ecological stability. Stumm (1970) further states that exploitation of adjacent soil occurs by: crop growing, seeding, weeds and grazing, fertilizing, irrigating, deforestation, converting grassland into cropland, applying herbicides and pesticides. These effects may be mitagated by: conservative land management through reforestation, restricting monoculture productivity, zoning (maintaining zones adjacent to open waters which are kept free of fertilizers and of low net productivity), controlling erosion, and using detritus agriculture.

An active problem of conservative land management through the aforementioned would be of undeniable value to the water quality in the Middle Missouri Basin.

The suspended sediment data (Tables 13 and 14) shows that Arrow Creek is the dominant silt carrier in this region. Others posing silt problems are Bullwhacker, Two Calf, Cow Creeks, and the Judith River. Of these, control of Arrow Creek would provide the most immediate benefit for the Missouri River. The Judith River provides a continued and larger flow whereas the other streams may not; from this standpoint, it is possible the Judith (i.e., irrigation flows) may provide a larger yearly silt load than any of the previously mentioned streams. Correction of erosional problems in Arrow Creek and the Judith River should be considered a necessary step in improving the Missouri River's silt load.

Remedies for saline drainages may become necessary if it is shown these waters are causing a degradation of high quality waters.

Miscellaneous non-point sources located in Lewistown are: two sawmills (one of which has difficulty with refuse reaching Big Spring Creek and should be corrected), Boyd Creek flows through the other mill; except for coliforms, no other problems were observed in Boyd Creek. In addition to the aforementioned there are two livestock holding facilities which may cause a problem.

IX. WATER QUALITY

Missouri River

In this basin water quality problems are associated with nutrients, sediment, and salts. Complete stream discussions ensue in this section. Continuous water quality data (Tables 9, 10, & 12) is available from the Missouri River at Fred Robinson Bridge and Fort Peck Dam.

During this survey, no violations of Montana's water quality regulations were observed on the mainstem Missouri River. The major problem lies with the river's tremendous sediment load. Typical water quality data is presented in Tables 9 and 12. Phosphorous levels did reach a value condusive to algal blooms (Table 10) near Zortman; however, no nuisance algal blooms have been reported at this site.

Suspended sediment data from the Missouri River at Fred Robinson Bridge (Table 11) shows that the months of March and May carried the largest loads of 1.5 and 8.0 x 10^5 tons/day, respectively.

Miscellaneous creeks flowing into the Missouri River and their state classification are: Eagle Creek (B-D_1), Dog Creek, Bullwhacker, Cow Creek (B-D_1), Two Calf Creek, Big Dry, and Armells Creek (not sampled). Of these Dog, Bullwhacker, Two Calf, and Big Dry exhibited saline tendencies (Tables 14, 22, & 23). High iron, sodium, and sulfur values tend to make these waters unpalatable.

Judith River

The Judith from Big Spring Creek to its confluence with the Missouri is classified as B-D_2, and from Big Spring Creek to its headwaters it is listed as a B-D_1 stream. The entire stream is basically a calcium bicarbonate water of good quality.

The Judith near Hobson, north of Danvers, and at the mouth has nitrate values that indicate over enrichment leading to excessive aquatic growths. Measured suspended solids were high near Hobson and at the mouth (Table 13). Several causative agents for headwaters silt load may be emanating from poor logging practices, agricultural procedures, and developers. The silt load at the mouth represents the cumulative effect of the aforementioned cultural activities.

Periphyton analysis (Table 30) at the mouth demonstrates the impact of water clarity on populations. Periphyton populations are small in this stream segment and those periphyton present reflect an excessive sediment load and an overabundant concentration of nutrients.

Depressed trout and benthic populations downstream of Hobson indicate water quality problems, and this is probably due to excessive silt loads--further explanation of problems caused by silt are presented in Sections VIII and X.

High coliform counts were also observed, but not in excess of water quality standards (Table 13).

Arrow Creek

Arrow Creek originates in the Highwood Mountains near Geyser and flows northeasterly approximately 60 miles (96 km) to its confluence with the Missouri River. The upper reaches (at Highway 230) are fair quality waters; however, from Highway 230 until its confluence the creek should be water quality limited. According to a schematic by the U. S. Salinity Lab, these waters would be high in salinity hazard and should not be used for irrigation. The tremendous silt loads, e.g., 6.9×10^4 and 9.9 tons/day (Table 16), carried by this stream comprise a large portion of the silt load in the Missouri River (Section VIII).

Periphyton analysis of this stream shows an unusual flora with southwestern and alkaline affinities. This stream is definitely an anomaly in the Middle Missouri Basin.

A small spring flowing into Arrow Creek (Table 16) is a sodium sulfate water exhibiting extreme hardness. This spring appears to be a typical example of saline seep. According to the U. S. G. S. classification (1970), this water would be classified moderately saline. The effects of this spring on Arrow Creek are probably negligible.

Concentrations of suspended sediment and salinity, particularly downstream from Highway 230, are high enough to seriously inhibit aquatic biota resulting in low and unusual periphyton populations and very low benthic populations.

Warm Spring Creek

Warm Spring Creek discharges groundwater originating from parts of the North Moccasin, South Moccasin, and Judith Mountains. Water quality data on Tables 17 and 25 shows that there are hard waters of good quality. Feltis (1973) describes flows and the geological formations from Warm Spring Creek.

Big Spring Creek

Big Spring Creek is a major tributary of the Judith River. This stream originates from the Big Snowy and southern part of the Judith Mountains. Miscellaneous flow records and a geological description is presented by Feltis (1973). This stream is a hard, calcium-bicarbonate type water.

Sampling was conducted upstream (south) and downstream (north) of Lewistown. Major problems with Big Spring Creek (north) are nutrients, coliforms, and silt loading (Big Spring Creek Watershed Work Plan, 1969). Tables 18 and 19 show excessive nitrates and coliforms. These excessive values are due to Lewistown's primary treatment plant. This problem should be alleviated when the city completes their secondary treatment plant.

Another problem located on this section of stream is Berg Sawmill. Necessary improvements should be made to prevent their waste from reaching Big Spring Creek. At present there has been little cooperation from the sawmill to mitigate their potential effect on Big Spring Creek.

As indicated by the nutrient levels and the periphyton analysis, this stream is in an enriched state.

Big Spring Creek south of Lewistown is basically water of good quality except for the presence of nitrates and suspended solids (Table 19). Due to cultural activities a reduction of suspended solids may not be attainable. Calculation of the silt load for 9/12/74 and 10/17/74 yielded values of 6.8 and 6.1 tons/day, respectively. The nutrient values in this section of stream may emanate from several sources. They are: trout hatcheries, a cattle holding facility, and septic tanks. No evidence of Milwaukee Railroad's discharge was identified in the stream; however, sampling was only conducted at their treatment facility.

This stream is reputed to be an excellent trout stream and a source of community pride. From the preceding and from a water quality viewpoint, efforts should be placed on preventing further encroachment upon Big Spring Creek. This would mean discouragement of housing development, prevention of septic tank flows, completion of Lewistown's secondary sewage treatment facilities, and maintaining the integrity of stream banks and adjacent feeder streams, e.g., Casino Creek, Boyd Creek, and the East Fork.

Beaver, Boyd, Casino and Cottonwood Creeks

Beaver, Boyd, Casino, and Cottonwood Creeks emanate from the Big Snowy Mountains and flow into Big Spring Creek. Water quality from these streams is presented in Tables 21, 22, and 24. A brief dissertation of each stream and problems encountered follows.

Beaver Creek is a very hard, magnesium-calcium, bicarbonate water. Water quality problems encountered were: high nitrates, coliforms, and solids. These parameters indicate an agricultural problem exists on this stream. Further investigation would be needed to pinpoint the source(s).

Fecal coliforms were the only parameter from Boyd Creek that was in violation of Montana Water Quality Standards. Except for the aforementioned, this small hard water stream appears to be of good quality (Table 22).

Casino Creek joins Big Spring Creek within the city limits of Lewistown. This stream is a hard, calcium-bicarbonate water with no serious water quality problem. The stream's nitrate and silt load may require further investigation. Water quality data for this station is on Table 22.

Cottonwood Creek is a hard, calcium-bicarbonate water (Tables 24, 25). Recorded nitrate values appear to be an unnatural situation for this stream. The BOD value recorded for 11/5/74 is abnormally high. The source of nitrate, high BOD, and suspended sediment may be agriculture in origin. A periphyton analysis of Cottonwood Creek indicates an enriched (abnormal) situation exists.

Ross Fork

This drainage is approximately 337 square miles and flows into the Judith River north of Hobson. These waters are hard, magnesium bicarbonate type with excessive nutrients, high BOD, and suspended solids (Tables 25, 26). Water Resources of Judith Basin (1963) lists the dominant water use as irrigation.

Whether cultural effects are causing the sediment and nitrate values is yet to be determined. However, the abnormal BOD indicates further investigation is warranted.

Sage Creek

Tables 22 and 25 depict water quality from this small perennial stream. This stream is a hard, calcium sulfate type water. Based on dissolved solids, this stream would be labeled moderately saline. Continued use of these waters for irrigation may result in intolerable salinity increases.

Little Trout Creek

Little Trout Creek, a small stream southwest of Lewistown, is a hard, calcium bicarbonate water. The chemical analysis (Table 22) shows that nitrate may be a water quality problem.

Table 9. Water Quality Stations Located on the Missouri River, 1974.

MISSOURI RIVER STATION/DATE	BOD_5	Dissolved Oxygen	Temp °C	pH	Conductivity umhos/cm @ 25°C	Turbidity JTU	Suspended Solids	Fecal Coliforms per 100 ml	Total Alkalinity	Sulfates	Total Hardness	Calcium Hardness	Magnesium (Mg)	Flow cfs	Chloride (Cl)	Sodium (Na)	Potassium (K)	Fluoride (F)	Bicarbonate (HCO_3)	Nitrate (NO_3)	Phosphate (PO_4)	Copper (Cu)	Manganese (Mn)	Cadmium (Cd)	Iron (Fe)	Zinc (Zn)	Arsenic (As)	Sodium Adsorption Ratio	Calculated Dissolved Solids	Sediment tons/day
@ Loma 09E 25N 18CA 7/8/74	---	----	20.5	8.3	385	15	35	--	69	60	160	120	4.7	----	8.9	40	---	--	---	0.05	.05	<.01	---	<.001	0.65	.04	.021	--	---	--------
@ Virgelle 11E 25N 24AB 7/9/74	---	----	19.8	8.6	371	15	33	--	69	61	154	96.8	6.8	----	10.0	38	---	--	---	0.04	.05	<.01	---	<.001	0.95	.02	.014	--	---	--------
Upstream of Arrow Creek 14E 22N 31DD 7/9/74	---	----	22.2	8.7	364	25	65	--	73	112	150	98	6.3	----	9.0	45	---	--	---	0.08	.03	<.01	---	<.001	1.35	.04	.018	--	---	--------
Downstream of Judith 23N 17E 27BA 7/10/74	---	----	21.0	8.5	420	200	744	--	72	85	180	119	7.4	----	8.8	46	---	--	---	0.87	.03	.02	---	.02	16.8	.10	.009	--	---	--------
PN Ferry 23N 16E 26 11/7/74	---	----	5.0	8.2	864	---	18	0	180	285	396	89	42	6000	7.0	41	2.7	--	220	3.8	.06	<.01	.03	<.001	0.44	.08	----	.9	691	2.9×10^2
Fred Robinson Bridge 22N 23E 36AB 7/11/74	---	----	21.8	7.7	679	---	4160	--	39	96	212	148	7.6	4800	8.2	78	---	--	---	0.18	.06	.04	---	<.001	45	.34	<.001	--	---	16.6×10^4
Fred Robinson Bridge 22N 23E 36AB 10/16/74	7.1	11.3	11.3	8.5	471	---	12	0	144	83	194	50	17	6400	8.5	23	---	--	171	0.35	.80	<.01	.02	<.001	0.27	.01	.006	.7	355	2×10^2
Fred Robinson Bridge 22N 23E 36AB 11/4/74																			183	0.27	.06	<.01	.03	<.001	0.20	<.01	----	.6	380	9.8×10^1

All results in mg/l unless otherwise designated.
Parameters are Total Dissolved.
Reference: Montana Water Quality Bureau.

Table 10

Water Quality Data from Middle Missouri River near Zortman, MT (Fred Robinson Bridge)

Date	Flow cfs	BOD_5 mg/l	Dissolved Oxygen mg/l	Temperature °C	pH	Conductivity umhos/cm @ 25°C	Total Alkalinity $CaCO_3$ mg/l	Sulfates mg/l	Total Hardness $CaCO_3$ mg/l	Calcium Hardness mg/l	Magnesium mg/l	Sodium mg/l	Potassium mg/l	Chloride mg/l	Turbidity FTU	Nitrate -N mg/l	Nitrite -N mg/l	Ammonia mg/l	Ortho Phosphate mg/l	Total Phosphate mg/l	Fecal Coliforms per 100 ml	Iron mg/l	Suspended Solids mg/l	Dissolved Solids mg/l
10/02/73	4,500	1.0	9.9	13.0	8.7	500	158	116	213	51.0	21.0	38.0	5.0	9.0	7.0	0.14	1.0	0	1.0	0.07	1	1.0	1.0	376
01/22/74	18,500	1.0	12.4	0.0	8.7	475	154	93.0	199.0	50.0	18.0	26.0	4.2	7.9	46.0	1.10	1.0	0.10	1.0	0.03	1	1.0	1.0	310
04/23/74	9,850	1.0	9.9	13.0	8.7	450	160	72.0	202.0	50.0	18.0	23.0	3.1	8.0	58.0	0.01	1.0	0	1.0	0.04	0	1.0	1.0	290

Reference: Data from U. S. Army Corps of Engineers, Omaha District.

Table 11
Suspended Sediment Data from Mainstem Missouri River near Landusky.
Water Year October 1971 to September 1972.

Month	mg/l						tons/day		Monthly Average tons/day
	Day	cfs	Max.	Day	cfs	Min.	Max.	Min.	
October	19	8,420	107	24	7,180	59	2,430	1,140	5.5×10^4
November	16	8,360	70	10	6,900	32	1,580	596	3.2×10^4
December	2	7,500	50	26	7,000	5	1,010	95	1.0×10^4
January	20	7,500	24	1	6,900	5	486	93	7.5×10^3
February	20	9,800	100	6	7,300	11	2,650	217	1.9×10^4
March	18	16,800	3,640	4	8,400	25	1.6×10^5	567	1.5×10^6
April	1	10,900	1,110	27	12,600	142	3.2×10^4	4,830	3.7×10^5
May	20	17,400	1,850	9	14,000	105	8.6×10^4	3,970	8.0×10^5
June	10	25,000	1,290	27	15,900	269	8.7×10^4	1.1×10^4	1.0×10^6
July	25	12,400	5,120	12	9,300	63	1.7×10^5	1,580	6.5×10^5
August	5	10,700	273	31	8,480	119	7,890	2,720	1.5×10^5
September	11	8,900	172	28	8,860	73	4,130	1,750	8.3×10^4

Yearly Total Tons 4.8×10^6

Ref. Water Resources Data for Montana, Part 2. Water Quality Records. U.S.G.S. 1972.

Table 12

Water Quality Data from the Missouri River and Fort Peck Reservoir.

Station	Dissolved Oxygen mg/l			Temperature °C			pH			Conductivity umhos/cm @ 25°C		
	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.
Missouri River nr Zortman, MT	10.3	12.8	7.8	11.7	25.5	0.0	8.2	8.7	7.5	512	1063	400
Fort Peck Reservoir @ Pines Recreation Area	10.7	13.1	8.6	12.6	24.0	2.7	8.1	8.7	6.9	612	720	524
Fort Peck Dam	11.1	13.8	8.0	6.8	13.0	0.0	8.2	8.7	8.7	626	738	540

Station	Total Alkalinity $CaCO_3$ mg/l			Sulfates mg/l			Total Hardness $CaCO_3$ mg/l			Calcium Hardness mg/l		
	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.
Missouri River nr Zortman, MT	157.2	296.0	135.1	90.1	170.0	50.0	191.3	250.9	70.0	131.4	158.9	109.7
Fort Peck Reservoir @ Pines Recreation Area	157.2	187.0	146.0	136.8	171.0	18.0	213.6	249.0	88.0	154.4	169.0	137.9
Fort Peck Dam	157.6	191.0	150.0	171.4	790.0	84.0	236.5	270.0	212.0	159.2	174.2	149.1

Station	Magnesium mg/l			Sodium Dissolved mg/l			Potassium Dissolved mg/l			Chloride mg/l		
	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.
Missouri River nr Zortman, MT	15.9	21.0	6.0	22.9	29.0	18.0	3.6	7.4	2.6	4.6	9.1	0.35
Fort Peck Reservoir @ Pines Recreation Area	19.2	22.0	8.0	41.5	54.0	30.0	4.7	9.0	2.6	4.7	10.3	0.10
Fort Peck Dam	58.7	100.5	19.0	43.9	48.7	38.0	3.2	4.4	1.5	6.8	18.2	0.07

Table 12
(continued)

	Turbidity JTU			Nitrate-N mg/l			Ortho Phosphate mg/l			Total Phosphate mg/l		
	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.
Missouri River nr Zortman, MT	26.7	50.0	2.0	0.16	0.39	0.00	0.04	0.12	0.01	0.09	0.45	0.00
Fort Peck Reservoir @ Pines Recreation Area	19.7	60.0	4.0	0.06	0.20	0.00	0.02	0.03	0.01	0.03	0.06	0.00
Fort Peck Dam	4	16.0	0.30	0.08	0.50	0.00	0.01	0.03	0.00	0.03	0.06	0.00

Data from Storet numbers 293007, 293004 and 293003. U. S. Army Corps of Engineers.

Table 13. Water Quality Data from the Judith River.

JUDITH RIVER Station	BOD_5	Dissolved Oxygen	Temperature °C	pH	Conductivity umhos/cm @ 25°C	Turbidity JTU	Suspended Solids (Effluents)	Fecal Coliforms	Total Alkalinity $CaCO_3$	Sulfates (SO_4)	Total Hardness $CaCO_3$	Calcium (Ca)	Magnesium (Mg)	Flow cfs	Chloride (Cl)	Sodium (Na)	Potassium (K)	Fluoride (F)	Bicarbonate HCO_3	Nitrate NO_3	Phosphate PO_4	Copper (Cu)	Manganese (Mn)	Cadmium (Cd)	Iron (Fe)	Zinc (Zn)	Arsenic (As)	Sodium Adsorption Ratio	Calculated Dissolved Solids	Sediment tons/day
South of Utica 14N 12E 35BD 10/17/74	2.5	10.4	10.4	8.3	529	----	8.0	6	191	87	252	59	26.0	17	2.0	13	---	---	233	0.22	0.08	<.01	<.01	<.001	----	<.01	<.001	0.4	419	
East of Utica 14N 13E 28BB 10/17/74	---	----	12.5	8.3	536	----	18.0	--	200	81	252	55	28.0	17	1.0	12	---	---	244	0.42	0.03	--	<.01	<.001	0.08	<.01	<.001	0.3	421	
Btw Hobson & Utica 14N 14E 10BD 11/7/74	3.3	10.8	8.0	8.2	560	----	2.0	92	218	71	276	67	26.0	14	2.6	12	2.9	---	266	1.7	<.03	<.01	<.01	<.001	0.08	<.01	----	0.3	449	
@ Hwy 87 14N 15E 6AB 7/2/74	6.1	9.2	12.0	7.3	409	5.3	8.0	70	115	33	197	52	16.2	125	0.06	5	---	---	140	80	<.03	--	---	<.001	-----	---	<.001	0.2	327	1.8
@ Hwy 87 14N 14E 6AB 8/7/74	6.8	10.4	19.0	8.4	465	4.0	4.0	40	191	60	224	49	25.0	31	0.3	10	2.9	.17	233	0.55	0.03	<.01	.07	<.001	0.1	.03	.003	0.3	380	
@ Hwy 87 14N 14E 6AB 10/16/74	2.5	10.0	9.5	8.3	552	----	2.0	42	226	72	272	48	37.0	18	3.0	13	---	---	276	1.9	0.03	<.01	<.03	<.001	0.08	<.01	<.001	0.3	452	
@ Hwy 87 14N 14E 6AB 11/5/74		9.1	6.1	8.1	553	----	8	0	218	76	266	65	25	9	2.1	13	3.8	---	266	1.9	---	<.01	<.01	<.001	0.04	<.01	----	0.3	453	
N of Danvers 18N 16E 32CC 11/6/74	3.5	12.3	6.0	8.2	736	----	28.0	81	204	177	350	82	35	245	4.6	26	2.4	---	249	9.3	0.06	<.01	<.01	<.001	0.25	---	----	0.6	586	18.5
Mouth 23N 16E 26BD 7/9/74	---	----	24.0	8.5	910	95	950	--	92	21	361	---	----	425E	4.2	70	---	---	---	0.78	0.06	<.01	---	<.001	21.5	.12	<.001	---	0.8	1090
Mouth 23N 16E 26BD 11/7/74	2.3	11.8	4.5	8.1	989	----	1	12	186	356	446	102	46	307	6.0	55	2.5	---	227	5.8	0.03	<.01	.03	<.001	0.39	Tr	----	1.1	800	

All results in mg/l unless otherwise designated.
Parameters are Total Dissolved.
Reference: Montana Water Quality Bureau.

Table 14. Miscellaneous Creeks Flowing into the Missouri River.

Station	BOD_5	Dissolved Oxygen	Temperature °C	pH	Conductivity umhos/cm @ 25°C	Turbidity JTU	Suspended Solids	Fecal Coliform per 100 ml	Total Alkalinity $CaCO_3$	Sulfates mg/l	Total Hardness $CaCO_3$	Calcium (Ca)	Magnesium (Mg)	Flow cfs	Chloride (Cl)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Nitrate (NO_3)	Phosphate (PO_4)	Copper (Cu)	Manganese (Mn)	Cadmium (Cd)	Iron (Fe)	Zinc (Zn)	Arsenic (As)	Selenium (Se)	Total Phosphate	Sodium Adsorption Ratio	Calculated Dis-solved Solids	Sediment tons/day
Eagle Creek 25N 13E 16DD 7/9/74	---	----	20.8	8.6	980	11	22.4	-	280	186	194	28	34	8	6.4	120	---	333	---	---	---	---	---	---	----	----	---	-----	3.6	711	0.4
*Dog Creek 23N 16E 248D 11/7/74	---	12.8	2.0	8.0	2944	----	8.0	9	348	1227	920	193	107	0.1	34	355	6.3	425	.62	.03	.01	.51	<.001	18	<.01	----	---	-----	5.1	2346	-------
Bullwhacker Crk 23N 21E 038B 7/10/74	---	----	25.9	7.9	2995	1000	37,400	-	---	117	631	---	---	117	--	450		---	.62	---	.25	---	<.001	175	2.4	<.001	<.001	-----	---	-----	$1.1x10^4$
Cow Creek 23N 22E 06DA 7/10/74	---	----	23.4	8.0	490	1000	34,390	-	---	162	426	---	---	159	--	310		---	.55	.04	.25	---	<.001	116	2.7	.004	<.001	-----	---	-----	$1.4x10^4$
Two Calf Creek 22N 23E 28AB 7/11/74	---	----	17.8	7.8	2520	1000	57,380	-	---	131	736	---	---	192	--	400		---	.47	---	.26	---	<.001	190	4.5	.012	<.001	42.0	---	-----	$2.8x10^4$
Unnamed Coulee 22N 23E 26AB 7/11/74	---	----	17.5	7.0	2870	1	3,020	-	---	135	665	---	---	---	--	505		---	.82	---	---	---	<.001	43	0.27	.012	<.001	0.17	---	-----	-------

*Low flow--all others at high flow.
All results in mg/l unless otherwise designated.
Parameters are Total Dissolved.
Reference: Montana Water Quality Bureau.

Table 15. Water Quality Data from Waste Dischargers in the Middle Missouri Basin, 1974.

STATION/DATE	BOD_5	Dissolved Oxygen	Temp °C	pH	Conductivity umhos/cm @ 25°C	Turbidity JTU	Suspended Solids (Effluent)	Fecal Coliforms per 100 ml	Total Alkalinity $CaCO_3$	Sulfates (SO_4)	Total Hardness $CaCO_3$	Calcium (Ca)	Magnesium (Mg)	Flow GPM	Chloride (Cl)	Sodium (Na)	Potassium (K)	Influent Suspended Solids	Bicarbonate (HCO_3)	Nitrate (NO_3)	Phosphate (PO_4)	Copper (Cu)	Manganese (Mn)	Cadmium	Iron, Total (Fe)	Zinc	Arsenic	Sodium Adsorption Ratio	Calculated Dissolved Solids	Percent Suspended Solids Reduction
Stanford lagoon effluent 16N 12E 15AB 10/16/74	11.9	13.0	10	9.0	986	--	38	1300	324	132	221	37	31	41	55	152	--	74.8	337	.65	12.0	<.01	<.01	<.001	.1	.02	----	4.4	786	20%
Stock pond effluent receiving Stanford effluent on Coyote Creek 10/16/74	4.4	10.5	11.4	8.9	1895	--	1	10	260	730	526	70	85	16.6	48	253	--	-----	271	.26	2.2	<.01	.04	<.001	.3	<.01	.005	4.8	1482	---
Denton lagoon effluent 18N 14E 15CB 10/16/74	12.0	11.5	17.5	8.8	1472	--	42.3	3300	319	395	464	53	81	60	55	172	--	161.3	343	4.0	9.5	<.01	.02	<.001	.13	.05	<.001	3.5	1135	76%
Lewistown primary plant 15N 18E 9AC 10/17/74	30	4.5	14.0	7.7	872	--	10.9	2800	251	136	378	97	33	2.2×10^6	28	33	--	105.5	306	20.0	.03	<.01	.03	<.001	.09	.04	<.001	.7	653	90%
Milwaukee RR @ Lewistown 15N 18E 23 10/17/74	Oil & Grease 4.6			7.4	1435	--	34	----	363	455	810	111	129	7	18	24	--	-----	443	.49	.34	.028	1.6	<.001	17.5	.08	.006	.4	1181	---

All results in mg/l unless otherwise designated.

Parameters are Total Dissolved.

Reference: Montana Water Quality Bureau.

Table 16. Water Quality Data from Arrow Creek North of Stanford, Montana.

ARROW CREEK Station	BOD_5	Dissolved Oxygen	Temperature °C	pH	Conductivity umhos/cm @ 25°C	Turbidity JTU	Suspended Solids	Fecal Coliforms	Total Alkalinity $CaCO_3$	Sulfates (SO_4)	Total Hardness $CaCO_3$	Calcium (Ca)	Magnesium (Mg)	Flow	Chloride (Cl)	Sodium (Na)	Potassium (K)	Fluoride (F)	Bicarbonate (HCO_3)	Nitrate (NO_3)	Phosphate (PO_4)	Copper (Cu)	Manganese (Mn)	Cadmium (Cd)	Iron (Fe)	Zinc (Zn)	Arsenic (As)	Selenium (Se)	Total Phosphate	Sodium Adsorption Ratio	Calculated Dis-solved Solids	Sediment tons/day
@ Hwy 230 19N 12E 13BA 7/2/74	---	8.2	16.0	7.5	2194	5	10	80	238	1044	956	189	118	2.4	13.4	180	---	--	291	-----	.05	.006	<.01	<.001	0.27	<.01	<.001	--	--	2.5	1832	-------
@ Hwy 230 19N 12E 13BA 8/7/74	DRY	----	----	----	----	----	-------	--	---	----	----	---	---	DRY	----	----	---	--	---	-----	---	----	------	---	-----	---	--	--	--	----	----	-------
@ Hwy 230 19N 12E 13BA 10/16/74	3.6	10.8	17.5	8.1	1910	----	1	8	231	940	736	171	75	10.4	18.0	233	---	--	282	3.2	.05	<.01	<.01	<.001	0.18	<.01	<.001	<.001	--	3.7	1722	-------
@ Hwy 230 19N 12E 13BA 11/5/74	---	----	----	8.1	1973	----	14	--	246	883	773	179	79	14	16.0	190	6.0	--	300	3.9	.03	<.01	0.03	<.001	0.2	<.01	--	--	--	3.0	3021	0.5
Ridgeways about 12 m. from mouth 11/5/74	---	----	----	8.5	3583	----	84	--	292	1775	1315	216	189	21	39	422	8.3	--	327	32	.06	<.01	0.09	<.001	1.1	<.01	--	--	--	5.1	----	-------
3 m. from mouth 22N 14E 17 11/5/74	---	----	----	8.3	3640	----	160	--	283	1905	1335	237	180	23	39	460	8.3	--	345	34.0	.12	----	------	---	-----	---	--	--	--	5.5	3209	9.9
Spring flowing into Arrow Crk 11/5/74	---	----	----	8.6	6450	----	28	--	587	3100	610	83	98	0.006	0.3	1450	6.0	--	645	15	.06	----	------	---	-----	---	--	--	--	25.5	5432	-------
Mouth 23N 15E 32CD 7/9/74	---	----	27.0	7.6	3390	1000	101,000	--	---	----	1680	---	---	255	15.0	315	---	--	---	0.92	.07	----	------	.09	19.0	3.8	<.001	<.001	48	----	----	6.9×10^4

All results in mg/l unless otherwise designated.
Reference: Montana Water Quality Bureau
Parameters are Total Dissolved.

Table 17. Water Quality from Warm Spring Creek North of Lewistown, 1974.

STATION/DATE	BOD_5	Dissolved Oxygen	Temp °C	pH	Conductivity umhos/cm @ 25°C	Turbidity JTU	Suspended Solids	Fecal Coliforms per 100 ml	Total Alkalinity $CaCO_3$	Sulfates (SO_4)	Total Hardness $CaCO_3$	Calcium (Ca)	Magnesium (Mg)	Flow cfs	Chloride (Cl)
17N 16E 17AD 10/16/74	3.3	9.1	18.5	8.2	1071	--	1	175	155	325	476	123	41	136	3.0
16N 17E 29DB 11/6/74	1.5	8.9	16.8	8.0	904	--	2	18	155	362	522	129	49	101	1.9

STATION/DATE	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Nitrate (NO_3)	Phosphate (PO_4)	Copper (Cu)	Manganese (Mn)	Cadmium (Cd)	Iron (Fe)	Zinc (Zn)	Arsenic (As)	Sodium Adsorption Ratio	Calculated Dissolved Solids
17N 16E 17AD 10/16/74	11	---	189	.93	.15	<.01	.02	<.001	.2	.02	.004	.2	693
16N 17E 29DB 11/6/74	6.5	1.7	189	.62	.06	<.01	Tr	<.001	.15	<.01	----	.1	739

All results in mg/l unless otherwise designated.
Parameters are Total Dissolved.
Reference: Montana Water Quality Bureau

Table 18. Water Quality Data from Big Spring Creek North of Lewistown, 1974.

STATION/DATE	BOD_5	Dissolved Oxygen	Temp °C	pH	Conductivity umhos/cm @ 25°C	Turbidity JTU	Suspended Solids	Fecal Coliforms per 100 ml	Total Alkalinity $CaCO_3$	Sulfates (SO_4)	Total Hardness $CaCO_3$	Calcium (Ca)	Magnesium (Mg)	Flow cfs
15N 18E 5DA 9/12/74	1.9	9.9	11	8.2	600	1	18	20	46.8	250.5	314	224	21.9	196
15N 18E 5DA 10/17/74	4.0	11.7	9.1	7.9	615	--	12	TNTC	176	146	305	95	16.3	144
15N 18E 5DA 11/7/74	2.8	9.5	9.2	8.0	565	--	2	2	176	117	296	80	24.0	286

STATION/DATE	Chloride (Cl)	Sodium (Na)	Potassium (K)	Fluoride (F)	Bicarbonate (HCO_3)	Nitrate (NO_3)	Phosphate (PO_4)	Copper (Cu)	Maganese (Mn)	Cadmium (Cd)	Iron (Fe)	Zinc (Zn)	Arsenic (As)	Sodium Adsorption Ratio	Calculated Dissolved Solids
15N 18E 5DA 9/12/74	0	6	---	--	214	0.22	.12	<.01	.01	<.001	.12	.02	<.001	.1	478
15N 18E 5DA 10/17/74	2.0	4.6	---	--	213	4.3	.16	<.01	.02	<.001	.1	<.01	<.001	.1	559
15N 18E 5DA 11/7/74	2.1	4.8	1.6	--	215	3.1	.18	<.01	.01	<.001	.08	<.01	--	.1	565

All results in mg/l unless otherwise designated.
Parameters are Total Dissolved.
Reference: Montana Water Quality Bureau.

Table 19. Water Quality Data from Big Spring Creek South of Lewistown, 1974.

STATION/DATE	BOD_5	Dissolved Oxygen	Temp °C	pH	Conductivity umhos/cm @ 25°C	Turbidity JTU	Suspended Solids	Fecal Coliforms per 100 ml	Total Alkalinity $CaCO_3$	Sulfates (SO_4)	Total Hardness $CaCO_3$	Calcium (Ca)	Magnesium (Mg)	Flow cfs
15N 19E 31AC 9/12/74	2.9	10.1	11.0	8.2	555	1	12	100	176	213.1	314	23.1	19.4	211
15N 19E 31AC 10/17/74	3.2	10.8	12.0	8.2	539	-	14	12	162	120	276	66	27	162
15N 19E 31AC 11/5/74	2	7.1	11.1	8.0	532	-		2	159	118	282	76	24	262

	Chloride (Cl)	Sodium (Na)	Potassium (K)	Fluoride (F)	Bicarbonate (HCO_3)	Nitrate (NO_3)	Phosphate (PO_4)	Copper (Cu)	Manganese (Mn)	Cadmium (Cd)	Iron (Fe)	Zinc (Zn)	Arsenic (As)	Sodium Adsorption Ratio	Calculated Dissolved Solids
15N 19E 31AC 9/12/74	0.0	5			199	0.08	.09							.1	449.5
15N 19E 31AC 10/17/74	2.0	4.0	---	--	198	1.8	.03	<.01	<.01	<.001	.13	<.01	<.001	.1	539
15N 19E 31AC 11/5/74	1.0	2.4	1.4		194	1.2	.03	<.01	<.01	<.001	.04	<.01	--	.1	415

All results in mg/l unless otherwise designated.
Parameters are Total Dissolved.
Reference: Montana Water Quality Bureau.

Table 20

Big Spring Creek below Casino Creek at Lewistown, Montana.
Water Temperature °C April 1 to September 1968.

Month		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Average
April	Max	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	13	14	12	11	11	11	14	--	--	--	--
	Min	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	8	9	8	7	9	11		--	--	--
May	Max	--	--	13	15	14	12	9	11	14	15	15	--	13	13	11	13	14	16	16	16	17	13	12	12	13	14	15	17	17	16	16	14
	Min	--	--	8	8	11	9	8	8	8	8	9	--	--	10	9	9	10	9	9	9	11	12	9	10	9	11	11	10	12	11	11	9
June	Max	18	18	14	13	12	12	13	16	13	14	15	16	14	13	14	16	17	18	19	16	17	16	17	13	17	17	19	17	13	12	--	15
	Min	11	12	12	12	12	11	11	11	12	11	11	12	11	9	11	11	12	12	13	13	12	13	13	12	11	12	13	12	12	10	--	11
July	Max	16	18	19	19	18	20	19	19	20	16	19	18	18	18	19	19	18	19	20	18	19	19	17	17	17	19	18	17	17	13	18	18
	Min	11	11	12	12	13	13	13	13	13	13	12	13	12	12	12	13	13	12	12	13	12	12	12	13	12	12	12	13	13	12	11	12
Aug	Max	19	19	18	17	19	19	19	18	16	18	18	18	17	17	13	16	15	15	16	15	16	16	15	18	18	17	17	15	17	17	17	16
	Min	11	12	12	12	12	12	12	13	13	12	12	12	12	12	11	11	11	12	12	12	11	12	12	11	11	12	11	12	11	11	11	11
Sept	Max	16	13	--	--	--	--	--	--	17	17	17	14	16	14	13	14	14	15	12	12	11	11	13	14	15	15	14	15	16	15	--	14
	Min	11	11	11	--	--	--	--	--	11	11	11	12	11	12	11	11	10	12	12	10	9	9	10	10	10	11	11	11	10	10	--	10

Location: 15N 18E 22

Big Spring Creek at Hanover, Montana.
Water Temperature °C May to September 1968.

Month		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Average
May	Max	--	--	--	--	--	--	--	--	--	--	13	13	14	13	11	12	13	13	14	14	16	14	11	12	14	13	14	16	16	14	14	--
	Min	--	--	--	--	--	--	--	--	--	--	7	9	11	11	9	8	9	9	6	9	11	11	9	9	9	11	11	11	12	12	11	--
June	Max	16	17	16	13	12	12	12	12	13	13	14	15	14	14	12	13	13	14	15	16	14	14	14	14	14	14	16	15	14	12	--	14
	Min	12	13	13	12	11	11	11	11	11	12	11	12	13	12	11	11	11	13	13	14	13	14	13	12	12	13	14	13	12	11	--	12
July	Max	13	14	16	17	18	18	18	20	21	19	20	18	18	18	19	19	18	19	20	18	18	19	17	17	17	19	18	20	20	16	17	--
	Min	10	12	13	14	14	15	16	15	15	16	14	16	14	14	14	14	14	13	14	14	13	14	14	14	14	13	14	15	16	13	11	--
Aug	Max	18	19	18	17	17	19	19	18	17	18	18	18	17	17	15	14	14	15	16	15	17	15	15	17	17	16	16	15	16	17	17	16
	Min	13	14	15	14	13	14	14	14	14	13	14	13	13	12	11	10	11	12	12	12	12	13	12	11	12	13	12	13	11	11	12	12
Sept	Max	14	13	--	--	--	--	--	--	16	16	17	15	16	14	12	13	12	14	13	11	9	9	12	13	13	14	12	14	13	13	--	13
	Min	12	11	9	--	--	--	--	--	11	11	12	13	11	12	10	9	9	11	11	9	7	7	8	8	9	9	9	11	9	9	--	9

Location: 16N 17E 27

Records: U.S.G.S. 1968 Water Resources Data for Montana, Part 2, Water Quality Records.

Table 21. Water Quality Data from Beaver Creek near Lewistown, 1974.

STATION/DATE	BOD_5	Dissolved Oxygen	Temp °C	pH	Conductivity umhos/cm @ 25°C	Turbidity JTU	Suspended Solids	Fecal Coliforms per 100 ml	Total Alkalinity $CaCO_3$	Sulfates (SO_4)	Total Hardness $CaCO_3$	Calcium (Ca)	Magnesium (Mg)	Flow cfs	Chloride (Cl)	Sodium (Na)
15N 17E 22BA 10/16/74	3.4	10.4	7.1	8.3	658	--	18	48	240	120	338	63	44	9	2.0	14
15N 17E 22BA 11/5/74	4.7	12.5	2.5	8.1	673	--	30	TNTC	251	102	346	91	29	12	1.8	11

STATION/DATE	Potassium (K)	Bicarbonate (HCO_3)	Nitrate (NO_3)	Phosphate (PO_4)	Copper (Cu)	Manganese (Mn)	Cadmium (Cd)	Iron (Fe)	Zinc (Zn)	Arsenic (As)	Sodium Adsorption Ratio	Calculated Dissolved Solids	Sediment tons/day
15N 17E 22BA 10/16/74	---	293	4.4	.15	<.01	.06	<.001	.33	.01	<.001	.3	540	.44
15N 17E 22BA 11/5/74	2.8	305	7.1	.03	<.01	.034	<.001	.36	<.01	--	.3	550	.97

All results in mg/l unless otherwise designated.
Parameters are Total Dissolved.
Reference: Montana Water Quality Bureau.

Table 22. Water Quality Data from Miscellaneous Creeks in the Middle Missouri Basin, 1974.

CATION/DATE	BOD_5	Dissolved Oxygen	Temp °C	pH	Conductivity umhos/cm @ 25°C	Turbidity JTU	Suspended Solids	Fecal Coliforms per 100 ml	Total Alkalinity $CaCO_3$	Sulfates	Total Hardness $CaCO_3$	Calcium (Ca)	Magnesium (Mg)	Flow cfs	Chloride (Cl)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Nitrate (NO_3)	Phosphate (PO_4)	Copper (Cu)	Manganese (Mn)	Cadmium (Cd)	Iron (Fe)	Zinc (Zn)	Arsenic (As)	Sodium Adsorption Ratio	Calculated Dissolved Solids	Sediment tons/day
ig Dry Creek of Jordan 3N 40E 9DB /9/74	---	----	17	8.7	1280	26	31	----	48	1027	142	27	9.8	0	3.7	260	---	253	0.08	.09	.02	.16	<.001	.85	.02	.003	10.9	997	---
asino Creek Lewistown 5N 18E 22AA 1/5/74	2.9	9.5	3.5	8.4	747	--	34	0	254	142	391	103	32	6.8	2.9	7.3	3.0	290	4.4	.03	<.01	.06	<.001	.36	<.01	----	0.2	595	.6
oyd Creek of Lewistown 5N 19E 18 1/8/74	---	13.0	4.5	8.1	767	--	1.0	TNTC	254	165	414	106	36	1.8	3.0	7.1	3.8	310	2.7	.03	<.01	<.01	<.001	.27	<.01	----	0.2	634	---
ittle Rock Creek of Lewistown 4N 16E 11AB 1/5/74	2.5	9.9	9.8	7.9	522	--	1.0	0	217	32	269	81	16.2	3.4	1.5	4.1	1.8	265	30	---	<.01	<.01	<.001	.04	<.01	----	0.1	431	---
age Creek ear Danvers 3N 15E 31DC 1/6/74	---	10.8	5.0	7.9	2671	--	34	8	258	1231	1127	208	148	6.1	45	225	9.0	315	0.89	.06	<.01	<.01	<.001	.44	<.01	----	2.9	2181	.55
ittle Trout Creek ear Sipple 3N 15E 1DB 1/8/74	---	----	4.3	8.5	721	--	20	----	256	91	318	80	29	2.9	4.7	20	2.7	288	11	.06	<.01	.03	<.001	.34	<.01	----	0.5	538	.15

ll results in mg/l unless otherwise designated.
arameters are Total Dissolved.
eference: Montana Water Quality Bureau.

Table 23

Water Quality Data from Big Dry Creek near Van Norman, Montana.

Station	Dissolved Oxygen mg/l			Temperature °C			pH			Conductivity umhos/cm @ 25°C		
	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.
Big Dry Creek nr Van Norman	9.9	13.5	6.5	11.9	32.0	0	8.4	8.7	7.7	2293	4500	279

Station	Total Alkalinity $CaCO_3$ mg/l			Sulfates mg/l			Total Hardness $CaCO_3$ mg/l			Calcium Hardness mg/l		
	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.
Big Dry Creek nr Van Norman	421.4	874.0	173.6	897.8	1700	260.0	209.8	338.0	66.0	108.4	157.1	75.2

Station	Magnesium mg/l			Sodium Dissolved mg/l			Potassium Dissolved mg/l			Chloride mg/l		
	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.
Big Dry Creek nr Van Norman	27.4	52.0	10.0	509.4	1000	159.0	7.5	38.0	1.0	4.2	19.4	0.00

Station	Turbidity JTU			Nitrate-N mg/l			Ortho Phosphate mg/l			Total Phosphate mg/l		
	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.
Big Dry Creek nr Van Norman	71.4	220.0	6.0	0.42	1.02	0.00	0.04	0.06	0.01	0.09	0.35	0.00

Data from U. S. Army Corps of Engineers Storet Number 293005.

Table 24. Water Quality Data from Cottonwood Creek near Lewistown, 1974.

STATION/DATE	BOD_5	Dissolved Oxygen	Temp °C	pH	Conductivity umhos/cm @ 25°C	Turbidity JTU	Suspended Solids	Fecal Coliforms	Total Alkalinity $CaCO_3$	Sulfates (SO_4)	Total Hardness $CaCO_3$	Calcium (Ca)	Magnesium (Mg)	Flow cfs	Chloride (Cl)	Sodium (Na)	Potassium (K)
15N 17E 22BA 10/16/74	3.3	10.9	7.3	8.2	559	--	12	29	233	57	280	78	21	6.5	2.0	6.5	
15N 17E 22BA 11/5/74	8.7	9.9	3.7	8.0	566	--	10	0	232	61	298	76	26	5.8	1.8	5.7	1.8

STATION/DATE	Bicarbonate (HCO_3)	Nitrate (NO_3)	Phosphate (PO_4)	Copper (Cu)	Manganese (Mn)	Cadmium (Cd)	Iron (Fe)	Zinc (Zn)	Arsenic (As)	Sodium Adsorption Ratio	Calculated Dissolved Solids	Sediment tons/day
15N 17E 22BA 10/16/74	284	8.9	.03	<.01	.046	<.001	.22	<.01	<.001	.2	457	.21
15N 17E 22BA 11/5/74	283	11.0	---	<.01	.01	<.001	.03	<.01	--	.1	466	.15

All results in mg/l unless otherwise designated.
Parameters are Total Dissolved.
Reference: Montana Water Quality Bureau.

Table 25--Chemical analysis of surface water from northern Judith Basin and adjacent areas
(Concentrations of dissolved constituents, dissolved solids, and hardness in milligrams per liter. Each water sample filtered through 0.45 micron filter.
All analyses by Montana Bureau of Mines and Geology.)

UNPUBLISHED RECORDS SUBJECT TO REVISION

No.	Stream and sampling site	Date of collection	Discharge (cfs)	Silica (SiO_2)	Iron[1/] (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Alkalinity as $CaCO_3$ total	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids, calculated from determined constituents	Hardness (Ca,Mg)	Noncarbonate hardness	Sodium adsorption ratio (SAR)	Specific conductance (micromhos at 25°C)	pH	Temperature °F	Temperature °C
1	Arrow Creek 19N12E11CD	6-24-70	70.9	8.8	0.00	0.02	45	91	130		264	0	216	530	8.6	0.6	2.7	944	490	270	2.5	1,410	7.9	66	19
2		8-27-70	.95	3.9	.02	.13	250	89	220		285	0	234	1,100	15	.3	10	1,820	990	750	3.0	1,890	8.1	80	26.5
3	Coffee Creek 19N14E2AC	6-23-70	2.5	1.2	.00	.03	180	390	630		474	8	401	3,000	5.6	1.9	47	4,450	2,100	1,700	6.0	4,700	8.3	81	27
		8-27-70	No flow																						
4	Wolf Creek 16N11E26DA	6-24-70	169	9.4	.00	.04	43	10	2.8		155	0	127	27	.8	.1	1.0	170	150	23	.0	287	7.9	56	13.5
5		8-28-70	10	3.9	.00	.01	66	23	4.0		264	0	216	46	1.1	.1	7.5	282	260	42	.1	689	8.0	53	11.5
6	Wolf Creek 18N14E13DD	5-27-71	<1 est.	1.0	.03	.00	140	130	260	7.3	325	0	266	1,100	40	.4	15	1,850	900	640	3.8	2,320	8.2	63	17
7	Wolf Creek 19N16E19CB	6-23-70	109	13	.00	.00	79	44	78		318	0	261	280	10	.4	2.2	668	380	120	1.7	965	8.1	79	26
8		8-27-70	.19	3.1	.02	.03	170	160	280		353	0	290	1,300	39	.2	18	2,100	1,100	790	3.7	2,380	8.0	75	23.5
9	Sage Creek 15N12E12CD	6-24-70	11.7	11	.00	.02	100	49	20		332	0	272	190	6.7	.4	11	552	450	180	.4	800	7.9	65	18.5
10		8-28-70	2.4	3.9	.00	.00	86	53	12		294	0	241	190	7.0	.1	37	538	430	190	.2	638	7.7	56	13.5
11	Sage Creek 18N16E31DD	6-23-70	13.2	3.6	.00	.00	160	110	170		299	0	245	910	27	.6	4.0	1,530	850	600	2.5	1,860	8.2	79	26
12		8-26-70	.50	2.3	.02	.02	250	150	280		274	0	225	1,500	41	.3	18	2,410	1,300	1,000	3.4	2,690	7.9	79	26
13	Judith River 13N12E17BA	6-24-70	411	6.2	.00	.00	39	10	1.7		155	0	127	17	.7	.1	1.2	152	140	11	.0	255	8.2	54	12
14		8-28-70	22	4.7	.00	.01	68	19	7.0		221	0	181	71	.9	.1	4.8	284	250	67	.1	440	8.0	58	14.5
15	Judith River 21N17E30DB	6-23-70	1,150[2/]	6.5	.00	.02	79	30	23		221	0	181	160	3.1	.4	2.2	414	320	140	.5	615	7.6	76	24.5
16		8-27-70	320[2/]	2.0	.02	.01	96	41	18		192	0	157	270	3.6	.3	9.1	530	410	250	.3	774	8.0	65	18.5
17	Rose Fork 14N15E11BC	6-24-70	41	8.2	.00	.01	71	45	57		301	0	247	210	10	.4	5.8	554	360	120	1.3	820	8.2	72	22
18		8-28-70	6	3.1	.00	.00	75	57	75		325	0	266	270	11	.2	20	672	420	150	1.5	896	8.1	68	20
19	Cottonwood Creek 16N17E28AA	6-22-70	284	4.6	.00	.05	59	14	3.3		215	0	176	35	.4	.1	2.7	225	200	29	.1	374	8.1	46	8
20		8-26-70	12.8	3.1	.00	.01	80	32	11		257	0	211	130	1.5	.3	27	415	330	120	.2	796	8.0	65	18.5
21	Big Spring Creek 16N17E27BB	6-22-70	248	6.8	.04	.03	97	28	9.4		251	0	206	160	1.7	.4	4.5	432	360	150	.2	632	8.1	67	19.5
22		8-26-70	145	3.1	.02	.01	86	29	2.0		219	0	180	150	1.7	.5	16	395	330	150	.0	583	7.9	59	15
23	Warm Spring Creek 18N16E21CD	6-23-70	144	8.3	.00	.02	140	48	17		221	0	181	350	2.0	1.1	2.0	672	530	350	.3	875	8.1	69	20.5
24		8-26-70	132	4.2	.02	.01	130	46	5.0		197	0	161	340	1.9	1.4	14	648	520	360	.0	824	8.0	71	21.5

UNPUBLISHED RECORDS
SUBJECT TO REVISION

1/ In solution at time of analysis.
2/ Approximate discharge computed from discharge of Judith River at 13N12E17BA, Rose Fork at 14N15E11BC, Cottonwood Creek at 16N17E28AC, Big Spring Creek at 16N17E27BB, and Warm Spring Creek at 18N16E21CD.

Reference: USGS Bulletin #87

Little Rock Creek

This small stream is west of Lewistown and eventually reaches the Judith River. The waters are hard, calcium bicarbonate type with abnormal nitrate values being observed (Table 22).

Wolf Creek

Drainage area of this stream is approximately 112 square miles. Near Stanford this stream is basically a calcium bicarbonate water; however, as the stream nears Denton, it becomes a sodium sulfate water of moderate salinity. It is believed this change in water quality is a direct result of saline seep and certain cultural practices that encourage the spread of saline seeps. Water quality data is presented in Tables 25 and 27. The sodium adsorption ratio (SAR) shows a downstream increase from 0.1 to 2.9 (Table 27). Waters with a SAR greater than 5 are not recommended for irrigation. The prevention of permanent land and water damage should be important factors in monitoring water quality in this drainage.

Dry Wolf Creek

Waters in this stream are of the magnesium sulfate type with high dissolved solids. These waters would be moderately saline. The dissolved solids content (Table 28) of these waters make them unfit for poultry and probably swine. There is consierable risk in using for pregnant or lactating cows, horses, or sheep, or the young of these species. In general, these waters should be avoided for livestock or irrigation use (Water Quality Criteria, 1972).

Big Dry Creek and Coffee Creek

Other creeks displaying saline qualities are Arrow Creek and Coffee Creek and Big Dry Creek (Tables 16, 22, and 25). Arrow Creek has been previously discussed (see pages 43 and 46). Big Dry flows into the Big Dry Arm of Fort Peck Reservoir. Big Dry waters are of the sodium sulfate type and are a result of the natural saline soils being drained by this stream.

Table 26. Water Quality Data from Ross Fork Creek west of Lewistown, 1974.

STATION/DATE	BOD_5	Dissolved Oxygen	Temp °C	pH	Conductivity umhos/cm @ 25°C	Turbidity JTU	Suspended Solids	Fecal Coliforms	Total Alkalinity $CaCO_3$	Sulfates (SO_4)	Total Hardness $CaCO_3$	Calcium (Ca)	Magnesium (Mg)	Flow cfs	Chloride (Cl)	Sodium (Na)
14N 16E 17AD 10/16/74	2.3	10.8	8.5	8.4	1011	--	26	164	282	248	418	28	85	20	11	73
14N 16E 17AD 11/5/74	10.7	10.7	3.8	8.1	1047	--	50	3	298	272	443	89	54	19	11	72

STATION/DATE	Potassium (K)	Bicarbonate (HCO_3)	Nitrate (NO_3)	Phosphate (PO_4)	Copper (Cu)	Manganese (Mn)	Cadmium (Cd)	Iron (Fe)	Zinc (Zn)	Arsenic (As)	Sodium Adsorption Ratio	Calculated Dissolved Solids	Sediment tons/day
14N 16E 17AD 10/16/74	---	339	11	.67	.01	.05	.001	.51	.01	.001	1.6	798	1.35
14N 16E 17AD 11/5/74	3.9	364	13	.03	.01	.04	.001	.49	.06	--	1.5	878	2.56

All results in mg/l unless otherwise designated.
Parameters are Total Dissolved.
Reference: Montana Water Quality Bureau.

Table 27. Water Quality from Wolf Creek near Stanford and Denton, Montana.

WOLF CREEK Station	BOD_5	Dissolved Oxygen	Temperature °C	pH	Conductivity umhos/cm @ 25°C	Turbidity JTU	Suspended Solids	Fecal Coliforms	Total Alkalinity $CaCO_3$	Sulfates (SO_4)	Total Hardness $CaCO_3$	Calcium (Ca)	Magnesium (Mg)	Flow cfs	Chloride (Cl)	Sodium (Na)	Potassium (K)	Fluoride (F)	Bicarbonate HCO_3	Nitrate (NO_3)	Phosphate (PO_4)	Copper (Cu)	Manganese (Mn)	Cadmium (Cd)	Iron (Fe)	Zinc (Zn)	Arsenic (As)	Sodium Adsorption Ratio	Calculated Dis-solved Solids
@ Hwy 230 17N 12E 21AD 7/2/74	6.0	8.2	13.0	7.4	508	3.2	5.0	630	210	60	261	69	21	8.1	2.4	5	---	--	256	0.21	<.03	---	---	---	---	---	---	0.1	414
@ Hwy 230 17N 12E 21AD 8/7/74	---	----	----	---	----	---	----	---	---	---	---	---	---	DRY	----	---	---	--	---	-----	----	---	---	---	---	---	---	---	----
@ Hwy 230 17N 12E 21AD 10/16/74	3.6	10.0	15.0	8.4	414	---	1.0	46	185	63	228	46	28	1.3	2.0	15	---	--	221	0.22	0.41	<.01	<.01	<.001	0.2	<.01	<.001	0.4	377
Near Denton 18N 13E 17DB 11/6/74	3.5	14.0	4.3	8.2	2092	---	22	0	326	815	820	117	128	23	33	190	4.2	--	398	32	0.09	<.01	.01	<.001	0.18	<.01	---	2.9	1717

All results in mg/l unless otherwise designated.
Parameters are Total Dissolved.
Reference: Montana Water Quality Bureau.

Table 28. Water Quality Data from Dry Wolf Creek near Denton, 1974.

STATION/DATE	BOD_5	Dissolved Oxygen	Temp °C	pH	Conductivity umhos/cm @ 25°C	Turbidity JTU	Suspended Solids	Fecal Coliforms per 100 ml	Total Alkalinity $CaCO_3$	Sulfates (SO_4)	Total Hardness $CaCO_3$	Calcium (Ca)	Magnesium (Mg)	Flow cfs	Chloride (Cl)
18N 15E 33BA 10/16/74	--	----	13.0	8.4	9100	--	2	82	479	5900	4060	305	801	0	179
18N 15E 33BA 11/6/74		11.7	3.4	8.2	5462	--	12	--	494	3110	2210	209	410	1.4	3.5

STATION/DATE	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Nitrate (NO_3)	Phosphate (PO_4)	Copper (Cu)	Manganese (Mn)	Cadmium (Cd)	Iron (Fe)	Zinc (Zn)	Arsenic (As)	Sodium Adsorption Ratio	Calculated Dissolved Solids
18N 15E 33BA 10/16/74	1300	---	572	75	.09	.016	.05	<.001	.15	.03	<.001	8.9	9138
18N 15E 33BA 11/6/74	730	7.8	603	35	.03	<.01	.02	<.001	.32	.01	--	6.8	5107

All results in mg/l unless otherwise designated.
Parameters are Total Dissolved.
Reference: Montana Water Quality Bureau.

X. BIOLOGICAL CONDITIONS

Biological conditions in the Missouri River from Fort Benton to Fort Peck Dam are virtually unknown. However, it is known that this section of the river is extremely important from the viewpoint of fish reproduction. Large spawning runs of paddlefish, sturgeon, goldeye, channel catfish, sauger, and several other species occur annually in the spring. Depending upon the particular species of fish, these spawning runs may extend the entire free flowing section of the river.

The river is a nursery area for the commercially important goldeye and buffalo which are harvested in Fort Peck Reservoir. Thus, the river is important in maintaining a viable fishery in Fort Peck Reservoir (Liebelt, personal communication, 1974). Three qualitative benthic samples were taken from the Missouri River in July, 1974, one at the Judith River mouth, one upstream, and one downstream of Arrow Creek's confluence with the Missouri River. These three sites all had diverse benthic populations consisting of caddisflies, mayflies, stoneflies, assorted midges, flies and mosquitos. This diverse benthic population indicates a high quality water.

In August, 1972, the U. S. Army Corps of Engineers conducted a biological reconnaissance survey of Fort Peck Reservoir. Phytoplankton and zooplankton samples were collected at nine stations (Table 29). The relative abundance of phytoplankton was considered low and indicative of a healthy lake. Aquatic vegetative growth is hindered by water level fluctuation, wind-wave action, and shore line erosion. Only coarse vegetation, such as cattail, is successful in the more protected reaches of the lake. This lack of aquatic vegetation may have a limiting influence on fishery reproduction especially for fishes needing vegetation for successful spawning, e.g., northern pike.

Most of the small streams in this basin have not been investigated; however, the Judith River and its tributaries have been cursorily investigated. Fisheries and benthic surveys of the Judith River (Montana Fish and Game, 1968, 1969, and 1971) show the viable trout populations in the headwaters. A fish survey downstream of Hobson yielded a few carp, goldeye, and mountain suckers. Diverse benthic population in the headwaters indicate water of good quality. Two downstream sites showed depressed populations indicating a possible water quality problem.

Abbreviated biological surveys have been conducted on the Judith River tributaries by the Montana Department of Fish

and Game. The largest tributary of the Judith River is Big Spring Creek which originates from the Snowy Mountains and flows through Lewistown.

Big Spring Creek has been the object of several studies including: Watershed Work Plan (Fergus County Soil and Water Conservation District, 1969) and Montana Fish and Game Investigations (reports 1969, 1970, 1971, and 1973). The watershed work plan was designed for flood protection of Lewistown. Big Spring Creek supports viable rainbow and brown trout populations. Benthic surveys on Big Spring Creek show two areas that have questionable water quality. Both sites are downstream of organic pollution sources, e.g., domestic sewage and fish hatchery wastewater.

Erosion and sewage are the major factors affecting water quality and the stream biota of Big Spring Creek. Damming of Big Spring Creek tributaries (Watershed Work Plan, 1969) is expected to alleviate the former. The City of Lewistown is expected to receive funds for secondary sewage treatment. When sewage treatment is improved water quality downstream of Lewistown should improve. A benthic survey of 1971 showed diverse populations in Big Spring Creek except near the Denton highway bridge. The lack of organisms at this time is unexplainable as no known sources of pollution exist in the area (Montana Fish and Game, 1972).

Warm Spring Creek receives approximately 80 percent of its flow (125 cfs) from a spring with a temperature of 20°C. The stream is stocked annually with rainbow trout. The lack of natural reproduction is attributed to the high water temperature.

A periphyton analysis was conducted at several stations in this basin. The results and interpretation are presented on the following table (30). A complete list of identified periphyton is presented in Appendix E.

Factors, in this basin, detrimental to the stream biota emanate from several sources and are discussed in other sections of this report.

Table 29
Zooplankton Analysis of Fort Peck Reservoir and Big Dry Arm.

SPECIES	Big Dry Creek Arm 22.1	Big Dry Creek Arm 13.2	1869.9	1890.3	1905.1	1919.4	1928.8	1949.6	1970
Daphnia pulex	VA	VA	VA	VA	VA	VA	VA	VA	VA
Daphnia retrocurva	VA	VA	VA	VA	VA	VA	VA	VA	VA
Diaphana soma sp.	C	C	C	O	C	C	O	C	C
Leptrodora sp.	O				O	O	O	O	O
Cyclops sp.	VA	VA	VA	VA	VA	VA	VA	VA	VA
Diaptomus sp.	A	VA	VA	VA	VA	VA	VA	VA	VA

Stations given as river mile.

VA - Very Abundant
A - Abundant
C - Common
O - Occasional

Partial results from U. S. Army Corps of Engineers Biological Survey on Fort Peck Reservoir.

Table 30. Periphyton Analysis* of Selected Stations in the Middle Missouri Basin, 1974.

STATION/DATE	DOMINANT GENERA	TROPHIC STATUS
Big Spring Creek N of Lewistown - 9/12/74	Navicula, Cymbella, Nitzschia, Cocconeis, Achnanthes	Enriched, similar to East Gallatin River.
Cottonwood Creek near Lewistown - 10/16/74	Oscillatoria, Phormidium, Synedra, Cymbella, Stigeoclonium	Enriched situation as indicated by dominance of blue-greens.
Warm Spring Creek @ Hwy 235 10/16/74	Cymbella, Synedra, Nitzschia, Diatoma, Audouinella	Low diversity, but normal flora.
Arrow Creek @ Hwy 230 10/16/74	Synedra, Navicula, Nitzschia, Amphiprora alata, Surirella	Unique stream displaying flora with southwestern affinities. Salinities important factor.
Judith River 3 miles S of Utica - 10/17/74	Oscillatoria, Cymbella, Fragilaria, Cyclotella, Diatoma	Normal flora & diversity.
Judith River near Utica 10/17/74	Filamentous bacterium, Cymbella, Synedra, Cyclotella, Nitzschia	Normal flora & diversity.
Judith River between Hobson and Utica - 11/7/74	Chara, Synedra, Fragilaria, Cymbella, Diatoma	Normal flora & diversity.

Table 30. (continued)

STATION/DATE	DOMINANT GENERA	TROPHIC STATUS
Judith River near Hobson @ Hwy 87 - 10/16/74	Oscillatoria, Cymbella, Synedra	Normal flora & diversity.
Judith River mouth @ Hwy 236 11/7/74	Diatoma, Synedra, Navicula, Nitzschia, Cymbella	Moderate diversity, unfavorable water quality conditions.
Missouri River @ P&N Ferry 11/7/74	Diatoma, Navicula, Synedra, Gomphonema, Nitzschia	Depauperate. Low diversity.

*Analysis by Dr. Loren Bahls, Environmental Quality Council, Helena, Montana.

For complete Genera list see Appendix.

XI. WASTE DISCHARGE PERMITS

The Montana State program of issuing discharge permits is operated under authority of the Montana Water Pollution Control Law. Statutory authority to apply and enforce state compliance schedules in state permits are Sections 69-4806(3), 4808.2(1)(f)(1) and (2), 69-4820, 69-4820.1, and 69-4823, Revised Codes of Montana, 1947. The applicable rule is existing MAC 16-2-14(10)-S11460, Montana Pollutant Discharge Elimination System (MPDES), Section (2)(b)(ii), effective March 8, 1974. Four municipal, four industrial, and four agricultural waste discharge permits have been issued by the state in the Middle Missouri Basin. Approximately six additional permits for agricultural discharges are anticipated.

The U. S. Environmental Protection Agency (EPA) is also issuing waste discharge permits in Montana. At this time EPA has issued one permit for the Middle Missouri Basin. This permit was issued to the Corps of Engineers at Fort Peck Powerhouse.

Public Law 92-500 requires publicly owned treatment works to meet secondary treatment requirements by July 1, 1977. However, at this time, only one of the municipalities has met the compliance schedule requirements of their permit. Compliance schedules are given to publicly owned treatment works that are not meeting the secondary treatment requirements.

Effluent characteristics are presented in Table 15, Section VII. Permit numbers and location of dischargers are presented in Table 31.

Federal permits are issued pursuant to the National Pollutant Discharge Elimination System (NPDES) created by the Federal Water Pollution Control Act Amendments of 1972 (FWPCAA of 1972). To eliminate the duplication of effort which formerly existed, Montana was given the authority to administer the NPDES program in Montana on June 10, 1974. Section 402 of the FWPCAA of 1972 provides that states with adequate water pollution control program elements may apply for and receive authority from the EPA to issue permits under the NPDES in their own states. Montana made the necessary revisions to the state water pollution control laws during the 1973 Legislative Session to provide the statutory authority for administration of the aforementioned NPDES program in Montana. In addition, the Department of Health and Environmental Sciences adopted a rule entitled the Montana Pollutant Discharge Elimination System (MPDES). The MPDES rule provides the additional program elements needed by the state to comply with rules and regulations promulgated by the administrator of EPA pursuant to Section 304(h) of the FWPCAA of 1972. Section 304(h) related to the state program elements necessary to administer the NPDES program.

Table 31. Middle Missouri Waste Dischargers Location, Permit Numbers and Compliance Schedules.

MUNICIPAL	MPDES NUMBER	LOCATION	COMPLIANCE SCHEDULE
Stanford	MT-0022161	16N 12E 15AB	Schedule being prepared
Denton	MT-0022462	18N 14E 15CB	Schedule being prepared
Lewistown	MT-0020044	15N 18E 09AC	Schedule being prepared
Jordan	MT-0021385	18N 38E 17A	Have met schedule requirement
Winifred	None	21N 18E 26	Schedule being prepared
Hobson	None		
Ft. Peck Powerhouse	0020567 (Federal)	26N 41E 15	Meeting secondary standards
AGRICULTURAL			
L. R. Ranch Company	MT-0022822	Jordan	None Required
Peterson Ranch	MT-0022853	Winifred	None Required
Peterson Ranch & Feedlot	MT-0023353	Garneil	None Required
Padej Feedlot	MT-0022730	Geraldine	None Required
Paradise Ranch	Application	Lewistown	None Required
Van Haur Feedlot	Application	Hilger	None Required
MISCELLANEOUS & INDUSTRIAL			
Big Springs Trout Hatchery Upper Unit	MT-0001031	Lewistown	Schedule being prepared
Big Springs Trout Hatchery Lower Unit	MT-0001023	Lewistown	Schedule being prepared
Trout Haven	MT-0028001	Lewistown	None Required
Spring Creek Trout Hatchery	Application	Lewistown	None Required
Milwaukee Railroad	MT-0000418	Lewistown	None Required
U. S. Gypsum	Application	E of Lewistown	None Required
Timberline Meat Packing	No discharge	Lewistown	None Required

XII. WASTE LOAD ANALYSIS

In the Middle Missouri River drainage basin, the following streams are designated as water quality limited:

1. Arrow Creek downstream from state highway 230;

2. Coffee Creek; and

3. Wolf Creek downstream from Denton.

All other streams within the Middle Missouri River basin are designated as effluent limited.

Some irrigation occurs in the upstream reaches of Arrow Creek, but this activity appears to have little effect on water quality. Arrow Creek from highway 230 to its confluence with the Missouri River carries a very large silt load and continually increases in salinity downstream. (Table 16). Salinity increases are due to the geology of the area and to saline seep springs. Saline springs may be aggravated by certain cultural activities (Bahls and Miller, 1973). There are no effluent discharges into Arrow Creek; therefore, no waste load allocation has been made for Arrow Creek.

Coffee Creek is moderately saline and the waters are marginal or unsatisfactory for irrigation due to a high sodium absorption ratio, and is marginal for livestock usage. Saline conditions on this stream probably are the result of saline seeps in the area and the area geology. There are no point discharges into this segment of Coffee Creek; therefore, no waste load allocation has been made.

Dry Wolf Creek (Table 28) shows high concentrations of dissolved solids, nitrates, and sodium. This stream is unfit for livestock watering and irrigation. The causative agents are thought to be salinity from saline seep springs and from the erosion and dissolution of materials from geological formations in the watershed. There are no effluents discharged into Dry Wolf Creek; therefore, no waste load allocation has been made.

XIII. MUNICIPAL FACILITY NEEDS AND INVESTMENTS

State water quality standards in the Middle Missouri Basin will not be violated by any municipal dischargers after application of secondary treatment. Several facilities are in need of upgrading to meet national secondary treatment standards. Needs, projected costs, and scheduling are summarized in Table 32. Data to evaluate cost effectiveness of treatment needs were not available.

Priority numbers assigned (Table 32) show only the relative ranking of various projects within the Middle Missouri basin. Relative ranking with projects statewide are given in Appendix D.

TABLE 32. MUNICIPAL SEWAGE TREATMENT NEEDS IN THE MIDDLE MISSOURI BASIN

Community (Priority No.)	Needs Description	1990 Design Population	Cost Estimate	Status
Stanford (3)	Expand present system to provide secondary treatment.	580	40,000	Low on FY 1976 priority list.
Denton (4)	Expand present system to provide secondary treatment.	350	30,000	Low on FY 1976 priority list.
Lewistown (1)	Expand present system to provide secondary treatment. Correct infiltration and storm water inflow.	8,500	1,600,000	Step 1 planning grant has been awarded.
Hobson (2)	Upgrade system to provide secondary treatment.	200	Estimate not Available	Step 1 planning grant declined in 1974.
Winifred (5)	Upgrade system to provide secondary treatment.	200	20,000	Not on priority list.

XIV. MANAGEMENT STRATEGY AND PLAN

The objective of water quality management is to maintain or enhance the quality of waters within the basin. To accomplish this, management programs and plans must be developed and implemented within the basin. After development and implementation, waters and wastewaters in the basin must be checked to determine actual effectiveness of the management program. Water quality management is an interative process; that is, a plan must be followed, the results checked, the plan modified, and the results again checked. A management strategy contains a number of elements. These are:

1. Permits.

   State and federal pollutant discharge permits are a basic tool in regulating the discharge of effluents to state waters. All discharges under the permit authority, either are or will be permitted or eliminated. The permit program regulates the quantity and quality of discharges of municipal and industrial wastes and certain agricultural wastes, including discharges from confined feeding operations and from irrigation drainage systems. The discharge permit also is used to regulate effluent from new or expanded discharges. As stream quality data are obtained, the permit can be used to insure that discharging effluents do not cause streams to exceed state water quality standards. All dischargers will be required, under the permit program, to achieve best practicable control technology not later than July 1, 1977. All publicly owned treatment works must achieve secondary treatment by July 1, 1977.

2. Intensive Surveys.

   Intensive water quality surveys are conducted for waters in the basin that have water quality problems. Objectives of intensive surveys are to determine pollution causes and potential means of elimination or abatement of pollutants. As additional water quality problems are identified within the basin, intensive surveys will be made. Intensive surveys also are conducted to determine the impact of specific wastewater discharges, land practices, or water treatment facilities that are installed in the basin.

3. Monitoring.

   Monitoring include a number of activities that provide measurement of chemical, physical and biological quality of water and changes in quality. Monitoring includes:

   (a) self-monitoring required by dischargers that are under the Pollutant Discharge Elimination System permit program

(b) compliance monitoring by the Water Quality Bureau and the EPA to ensure that permitted discharges are in compliance with allowable limits;

(c) periodic sampling and analysis of water at selected stations;

(d) aerial and ground observations of basin waters and practices or facilities that effect water quality;

(e) the use of continuous water quality recording instrumentation to obtain a continuous record of selected water quality parameters;

(f) short-duration surveys of stream segments to determine changes in quality in streams as the water progresses downstream

(g) evaluation of water quality data to determine trends and to identify problems.

The basic objective of the monitoring effort is to determine the status of water quality and to determine variations in water quality. The monitoring network also is useful for determining the impact of activities within the basin that influence water quality. Such activities include those that potentially degrade water quality, such as logging, mining, and certain agricultural practices; and those activities that may enhance water quality, such as installation of improved treatment facilities.

4. Facilities construction, operation, and maintenance.

Federal and state grant programs are available to assist municipalities in the construction of sewage treatment facilities, which include outfall and interceptor sewers. Such facilities provide improved treatment of wastewaters and reduce the impact of wastewaters on the receiving water body. An integral part of the waste treatment facility program is adequate operation and maintenance of the facilities after construction is completed. The state requires that all operators be certified and the state provides on-the-job training and annual schools for operators.

5. Operation and maintenance.

Periodic inspections are made of municipal and industrial wastewater treatment facilities in the basin. The objective of operation and maintenance inspections is to ensure that waste treatment facilities are operated in a manner that provides the best possible treatment.

6. Information and Education.

Information is made available to the public through bureau publications, talks, technology transfer seminars, and through answering inquiries. Public hearings and environmental impact

statements are presented for important or controversial issues in the basin. Information and educational efforts are informing the public of water quality conditions in the basin and factors that can degrade water quality. This effort stresses development of a pollution prevention attitude.

7. Regulations and Guidelines.

To prevent water quality degradation within the basin, regulations and guidelines that relate to water quality will be made available to residents of the basin through state and county organizations. This includes regulations that influence water and wastewater from subdivisions and private and public water and wastewater facilities. In addition, existing regulations may be changed or updated to control activities within the basin that will degrade water quality. The Department of Health and Environmental Sciences in cooperation with other agencies, will develop guidelines that will abate or eliminate pollution resulting from storm drainage, storm sewer discharges and non-point sources, including irrigation practices, road building, construction, logging practices, overgrazing and other practices. Land use is recognized as a dominant factor controlling water quality in the basin. Those activities which influence land use will be examined to determine how water quality degradation due to improper land uses can be eliminated to be abated.

8. Enforcement.

Violations of Montana's laws, rules, or permits are investigated and are subject to injunction, civil penalties, or criminal penalties. The rules and regulations upon which enforcement is based are periodically reviewed and updated to insure that Montana's laws and regulations are adequate and can be properly enforced.

9. Program Coordination.

Montana's water pollution control program will be coordinated with other state, federal and local agencies to ensure that the activities of these groups receive adequate information with respect to their water quality related activities. This includes review of proposed programs, laws, regulations and proposed technical investigations that relate to water quality.

The elements of basin water quality management described above generally are applicable to all basins. Specific steps that will be taken in the Middle Missouri Basin are:

1. Permits.

Permit conditions and progress in meeting compliance schedules will be reviewed for all dischargers in the basin in FY 1976. All

permits will be reviewed prior to expiration to determine what revisions are needed for the reissued permits. All dischargers that have not received permits, but are under the NPDES or MPDES, will receive permits in FY 1976.

2. Intensive Surveys.

In FY 1976 intensive surveys are planned for Arrow Creek, Coffee, Ross Fork and Beaver Creeks. As additional water quality problems are identified and as funding is available, additional intensive surveys will be conducted.

3. Monitoring.

See Section XII (Monitoring and Surveillance) for specific basin strategy and plans.

4. Facilities Construction, Operation and Maintenance.

Inadequate municipal sewage treatment has been ranked according to priority (Page 75) and will be upgraded to meet secondary treatment by July 1977. Industrial treatment of wastewater discharges will meet best practicable treatment by July 1977. Some EPA and state grant funds will be available for municipal sewage facilities. Sewage treatment plant operator training and the operators school will be available for the basin.

5. Operation and Maintenance.

At least one inspection will be made annually of each municipal sewage treatment facility in the Middle Missouri basin. Critical installations will be provided additional inspections when needed and facilities with special operation and maintenance problems will be provided with technical assistance.

Major industrial dischargers are examined at least twice per year and minor dischargers are examined as needed and as manpower and funding are available.

6. Information and Education.

The general bureau information and education program will be utilized in the basin. No specific basin programs are planned for the next year.

7. Regulations and Guidelines.

During the next year the regulatory framework for water pollution control will be reviewed by the bureau attorney. The adequacy of the regulations to prevent pollution will be assessed.

8. Enforcement.

Enforcement actions will be taken as needed for prosecution of violations of the state's water pollution laws and regulations.

9. Program Coordination.

Federal, state and private organizations that have water quality related actions in the basin will be informed of the Bureau's efforts and will be requested to furnish information on these basin programs.

XV. MONITORING AND SURVEILLANCE

Water quality monitoring and surveillance programs represent a major investment of time and funds. Such programs should obtain the needed information at least cost. To properly design a cost-effective monitoring system, a number of factors must be considered including:

1. Adequacy of baseline data in the basin;

2. Status of the stream as a receiving water for pollutant discharges;

3. Data needs for point source discharges under state and federal permit programs;

4. Existing and potential water quality problems;

5. Data needs for enforcement actions;

6. Available time and funding;

7. Existence of other water quality data collection programs in the area.

Flexibility in scope and intensity is an important aspect of a proposed program. A variety of factors can influence an area's water quality; these include industrial, municipal, and agricultural developments, federal and state regulations, and water transfers. With the range of developments that can occur in a basin, a long-term management strategy cannot be efficiently developed. Water quality surveillance and monitoring is directed at short-term conditions (up to five years in the future) and is revised annually.

Monitoring and surveillance recommendations are presented in this report. The detailed basin monitoring and surveillance program is developed by the Water Quality Bureau as part of the annual water pollution control program plan. Monitoring and surveillance activities are conducted by a variety of organizations including communities and industries, federal and state agencies, private individuals and organizations. Commonly, acute problems such as toxic conditions causing fish kills, oil spills, etc. are recognized by basin residents or persons working in the basin.

The following is the recommended monitoring program for the Middle Missouri Basin.

1. Compliance Monitoring.

   It is recommended that the following point discharges be checked by the Water Quality Bureau to check compliance with permit conditions.

   Lewistown
   Stanford
   Denton

Suspended solids, BOD_5, fecal coliforms, and flow will be monitored in all municipal discharges; residual chlorine will be measured where chlorination is provided.

Similarly, it is recommended that the following industrial discharges be monitored by the Water Quality Bureau to check compliance with permit conditions:

Milwaukee Railroad, washing facilities, Lewistown
U. S. Gypsum, floor washings, Lewistown
Big Spring Fish Hatchery, Lewistown

Frequency and parameters to be monitored for irrigation return flows have not, as yet, been defined. Feedlots designed are basically as non-discharging facilities.

2. Self-Monitoring.

All waste dischargers under MPDES permit are required to periodically sample and analyze their wastewater and report these results to the Bureau and the Environmental Protection Agency. The parameters to be monitored are specified in the conditions of the permit.

3. Water Quality Surveillance Network.

The water quality surveillance network is composed of water quality sampling stations on streams, water bodies and groundwater. Surveillance is recommended for the streams listed on Table 33.

Recommended surveillance frequency varies from continuously to quarterly and parameters to be monitored generally include flow, sediment, temperature, nutrients, common ions, and coliform organisms.

The actual basin surveillance program is described in the bureau annual water pollution control program plan. Details of sampling frequency and parameters also are described in this plan.

Biological assessment and water quality runs will be carried out at selected sites in the basin. Biological assessments involve periodic quantitative and/or qualitative benthic organism assessments. Water quality runs involve an intense instream survey of a few water quality parameters at a large number of stations. The sampling is designed to measure changes in stream quality as the water moves downstream. Sites selected for these evaluations are described in the Bureau's annual pollution control plan.

4. Aerial and Ground Surveys

Examination of streams and water bodies is done as part of the routine bureau visits to the basin. Other agencies and organizations also commonly notice stream conditions during their basin trips. Detailed aerial surveillance and actual stream examination on foot or by boat is required for selected problems.

5. Data Interpretation and Analysis

Surveillance and monitoring activities develop water quality data that must be compared with previous data, water quality standards, permit conditions, etc. Results of water quality testing must be analyzed and interpreted to understand temporal and spatial changes in water quality and determine if the sampling network is adequate to meet program objectives.

Table 33. Middle Missouri Water Quality Surveillance Stations.

STATION NAME	AGENCY	LOCATION	SAMPLING INTERVAL	WATER QUALITY PARAMETER
Fred Robinson Bridge	USGS	22N 23E 36AB	Monthly	DO, Ca, Mg, Na, SO_4, Cl, S.S., Nutrients, S.C., Temp, pH, Alk, Flow
Fort Peck Dam	U.S. Army Corps of Engineers	26N 15E 15	Monthly	DO, Temp, Flow, pH
Mouth of Judith River	WQB	23N 16E 26BD	To be determined	S.S., DO, BOD, Temp, Nutrients, Flow, S.C., Ca, Mg, Na, SO_4, Turbidity
Judith River near Danvers	WQB	18N 16E 32	To be determined	S.S., DO, BOD, Temp, Nutrients, Flow, S.C., Ca, Mg, Na, SO_4, Turbidity
Judith River near Utica	WQB	13N 13E 28	To be determined	S.S., DO, BOD, Temp, Nutrients, Flow, S.C., Ca, Mg, Na, SO_4 Turbidity
Mouth of Arrow Creek	WQB	23N 15E 32CD	To be determined	S.S., DO, BOD, Temp, Nutrients, Flow, S.C., Ca, Mg, Na, SO_4, Turbidity

Table 33
(Continued)

STATION NAME	AGENCY	LOCATION	SAMPLING INTERVAL	WATER QUALITY PARAMETER
Arrow Creek @ Hwy 230	WQB	19N 12E 13BA	To be determined	S.S., DO, BOD, Temp, Nutrients, Flow, S.C., Ca, Mg, Na, SO_4, Turbidity
Big Spring Creek	WQB	15N 18E 05DA	To be determined	S.S., DO, BOD, Temp, Nutrients, Flow, S.C., Ca, Mg, Na, SO_4, Turbidity, Coliforms

Other creeks showing high salinity and nutrient values may need sampling, but these should be funded under separate studies, e.g. Cottonwood Creek, Beaver Creek, Ross Fork Creek.

XVI. WATER QUALITY PROBLEMS AND FUTURE NEEDS

A variety of point and non-point pollution problems have been identified in the Middle Missouri basin and are summarized in approximate order of priority in Table 34. The problems originate from a variety of sources and have a variation in severity and in potential for correction. This report generally has identified the location, type of problems, and presents data concerning these problems. Considerable additional effort is needed to further define these problems, determine techniques for abatement or elimination, and implement actions to correct the problems.

Two basic elements are needed in the basin to successfully improve water quality and prevent further quality degradation. These are (1) a program of education and information to relate the problems to the public, and (2) increased funding for further technical identification of the problem and potential solution.

Most pollution problems identified in the basin are from non-point sources and are complex. The problems require detailed study to determine the source, extent and magnitude of pollution or degradation. Nutrient, sediment, and coliform pollution problems are difficult to assess due to seasonal variations, expense of data collection, and multiple sources. Further intensive surveys will be needed to accurately assess the basin's pollution problems.

TABLE 34. SUMMARY OF WATER POLLUTION PROBLEMS IN THE MIDDLE MISSOURI BASIN, MONTANA

Problem	Stream or Area	Status	Potential for Correction	Methods of Correction
Sediment, coliform, nutrient increases in streams due to livestock grazing, feedlots, irrigation returns and logging. (Severe in some areas.)	Big Spring Creek, Judith River, Ross Fork, Beaver Creek and other streams.	Little data available. Needs extensive survey and land use investigation. Problem probably increasing.	Poor to fair. Economical problem. Technical corrective measures available.	Relocation of feedlots, stream bank protection by fencing and plant cover. Increased efficiency of water use. Improvded logging practices.
Increased salinity due to saline seeps. (Very severe problem.)	Arrow Creek, Coffee Creek, Big Spring Creek and many others.	Problem increasing rapidly due to more intensive and changing land use. Some technical studies underway but far less than needed.	Poor to fair. Economics of land use involved. Technical corrective measures not well known.	Cropping practice changes; land use changes. Much more work needed on corrective measures.
Increased coliform, nutrient and BOD due to improper or nonfunctioning septic tank systems. (Moderately severe problem.)	Big Spring Creek near Lewistown	Poorly understood. Additional housing planned along stream. Needs intensive survey.	Good.	Correct improperly functioning tanks. Insure new tanks properly installed. Extend city sewage collection system.
Increased nutrients and coliform concentrations from Lewistown sewage treatment plant. (Moderately severe problem.)	Big Spring Creek below plant.	Secondary treatment facility in planning stage.	Good.	Secondary treatment will improve effluent.
Organic loading, sludge due to disposal of saw mill wastes.	Big Spring Creek, Boyd Creek.	Corrective actions requested but little action to date. Problem not decreasing.	Good. Technical solution readily available.	Prevent drainage of lumber wastes into streams. Remove debris from stream banks.

Problem	Stream or Area	Status	Potential for Correction	Methods of Correction
Nutrient and organic loading from fish hatcheries.	Big Spring Creek	Problem not well defined. More stringent effluent standards will be required in near future. Additional fish rearing planned.	Probably good. Problem not well defined.	Treatment of wastes. Additional work needed on problem and potential corrective measures.
Chlorine, ammonia, temperature from swimming pool discharge.	Big Spring Creek	Pool drained to creek periodically. Problem persistent.	Good	Don't drain pool or drain to sewage system or use land for disposal (irrigation).

XVII. ENERGY DEVELOPMENTS

The Middle Missouri River drainage basin has substantial energy resources in the form of petroleum and coal. There is continued petroleum exploration and production in the basin, particularly in Petroleum County. Petroleum exploration activities are generally increasing; however, little water pollution has resulted from existing petroleum facilities, and little water pollution is expected from future petroleum production. The basin also contains substantial quantities of strippable subbituminous and lignite coal. These reserves are principally in the eastern and southern portions of the basin, and as yet, have had little development. The Burlington Northern Corporation has announced plans to develop a substantial coal based synthetic fuel production facility near Fort Peck Reservoir. This facility will use coal from the basin and will use water from Fort Peck Reservoir in the coal conversion process.

Impacts of energy developments in the Middle Missouri basin will be dependent upon the type of development and will be process dependent and site-specific. Presently, water quality is not significantly impacted by energy developments; however, the potential for water quality degradation due to future energy developments, including coal mining and energy conversion plants and increased populations, is large. There is a great deal of state-wide concern about the impact of such developments on both surface and groundwater quality in the basin. State land reclamation and water pollution regulations are basic regulatory frameworks in controlling environmental impacts on water quality.

Coal conversion processes, including synthetic fuel production and fertilizer production is another threat to water quality. These processes involve not only mining but conversion of coal with its associated pollution problems. Due to the wide variety of conversion processes, water quality problems cannot be predicted.

There has been little technical investigation of water quality in the basin, and there has been no assessment of the potential impact of energy developments on water quality. These technical assessments must be made in the near future to ensure that the proposed energy developments will not cause degradation of water in the basin.

A P P E N D I X

APPENDIX A

GLOSSARY

Symbol	Definition
BOD_5	Five-day biochemical demand
cfs	Cubic feet per second
gpcd	Gallons per capita per day
gpd	Gallons per day
gpm	Gallons per minute
JTU	Jackson turbidity unit
lbs/capita/day	Pounds per capita per day
lbs/day	Pounds per day
ml	Milliliter
mgd	Million gallons per day
mg/l	Milligrams per liter
sq. ft.	Square feet
TR	Total recoverable
tpd	Tons per day
μmhos	Micromhos per centimeter
$<$	Less than
$\leq$	Less than or equal to
$\geq$	Greater than or equal to
$\sim$	Approximately
BPT	Best practical treatment
WQB	Montana Department of Health & Environmental Sciences, Environmental Sciences Division, Water Quality Bureau
F & G	Fish and Game, Montana Department of
MDHES	Montana Department of Health & Environmental Sciences
MPDES	Montana Pollutant Discharge Elimination System
NPDES	National Pollutant Discharge Elimination System
BuRec	Bureau of Reclamation
EPA	U. S. Environmental Protection Agency
NOAA	National Oceanographic and Atmospheric Administration
SCS	U. S. Department of Agriculture, Soil Conservation Service.
USGS	U. S. Geological Survey
USPHS	U. S. Public Health Service

MONTANA STATE DEPARTMENT OF HEALTH
AND
ENVIRONMENTAL SCIENCES

MAC 16-2.14(10)-S14480 WATER QUALITY STANDARDS

(1) Policy statement. The following standards are adopted to establish maximum allowable changes in water quality and establish limits for pollutants which affect prescribed beneficial uses of state waters. The department adopts as a rule the policy that best practicable treatment and control of waste, activity and flow is to be provided to maintain dissolved oxygen and overall water quality at the highest possible levels, and water temperatures, coliform bacteria concentrations, dissolved chemical substances, toxic materials, radioactivity, turbidities, color, odor and other deleterious substances at the lowest possible levels.

(2) Application of standards. The water quality standards are composed of water-use classifications [section (4)], water-use descriptions and specific water quality criteria [section (5)], and general water quality criteria [section (6)].

(a) General water quality criteria apply to all state waters except where in this rule specific water quality criteria are more applicable to a specific water-use classification.

(b) In order to carry out the objective of the rule, existing discharges to state waters shall be brought into compliance with the standards as soon as practicable, and in no case later than three years from the effective date of the rule.

(3) Definitions. Unless statutory definition or the context otherwise requires in this rule:

"Conduit" means any artificial or natural duct, either open or closed, for conveying liquids or other fluids.

"Dewatered stream" means a perennial or intermittent stream whose water has been removed for one or more beneficial uses.

"EPA" means the U. S. Environmental Protection Agency.

"Intermittent stream" means a stream or portion of a stream that flows only in direct response to precipitation; it receives little or no water from springs and no long-continued supply from melting snow or other sources.

"Naturally occurring" means conditions or material present from runoff or percolation over which man has no control or from developed land where all reasonable land, soil and water conservation practices have been applied. Conditions resulting from dams in existence as of July 1, 1971 are natural.

"Mixing zone" means that volume of state water wherein any pollutant may exceed allowable water quality standards.

"Pesticide" means insecticides, herbicides, rodenticides, fungicides or any substance or mixture of substances intended for preventing, destroying, controlling, repelling, altering life processes, or mitigating any insects, rodents, nematodes, fungi, weeds and other forms of plant or animal life.

"Residue" means oils, floating solids and sludge deposits.

"Sediment" means solid material settled from suspension in a liquid; mineral or organic solid material that is being transported or has been moved from its site of origin by air, water or ice and has come to rest on the earth's surface, either above or below sea level; or inorganic or organic particles originating from weathering, chemical precipitation or biological activity.

"Settleable solids" means inorganic or organic particles that are being transported or have been transported by water from the site or sites of origin and are settled or are capable of being settled from suspension.

"Sewer" means a pipe or conduit that carries wastewater or drainage water.

"State waters" means any body of water, irrigation system or drainage system, either surface or underground. This section shall not apply to irrigation waters where the waters are used up within the irrigation system and said waters are not returned to any other state waters. The term "state waters" as used in this rule does not include underground water.

"Storm sewer" or "storm drain" means a sewer that carries storm water and surface water, street wash and other wash waters, or drainage but excludes sewage and industrial wastes.

"True color" means the color of water from which the turbidity has been removed.

"Turbidity" means a condition in water or wastewater caused by the presence of suspended matter resulting in the scattering and absorption of light rays.

(4) Water-use classifications.

MISSOURI BASIN

Missouri River Drainage

Missouri River (mainstem) from Sun River to Rainbow Dam . . . . B-D_2

Missouri River drainage from Rainbow Dam in Great Falls to the North Dakota state line except the portion of the mainstem and the tributaries listed below . . . . . B-D_3

Teton River drainage to and including Deep Creek near Choteau . . . . . B-D_1

Remainder of Teton River drainage . . . . . B-D_2

Eagle Creek drainage to but excluding Dog Creek . . . . . B-D_1

Remainder of Eagle Creek drainage . . . . . B-D_3

Judith River drainage to Big Spring Creek . . . . . B-D_1

Big Spring Creek drainage to the Mill Ditch headgate near the southern city limits of Lewistown . . . . . B-D_1

Big Spring Creek (mainstem) from the Mill Ditch headgate to the Judith River . . . . . B-D_2

Tributaries to Big Spring Creek from the Mill Ditch headgate to the Judith River . . . . . B-D_1

Judith River (mainstem) from Big Spring Creek to the Missouri River . . . . . B-D_2

Tributaries to the Judith River from Big Spring Creek to the Missouri River . . . . . B-D_1

Cow Creek drainage to but excluding Al's Creek . . . . . B-D_1

Remainder of Cow Creek drainage . . . . . B-D_3

Musselshell River drainage to and including Hopley Creek near Harlowton . . . . . B-D_1

Musselshell River drainage from Hopley Creek to but excluding Half Breed Creek near Roundup except American Fork listed below . . . . . B-D_2

American Fork drainage . . . . . B-D_1

Musselshell River drainage from and including Half Breed Creek to Fort Peck Reservoir except Flatwillow Creek drainage listed below . . . . . B-D_3

Flatwillow Creek drainage (may be the Box Elder Creek drainage) near Mosby . . . . . B-D_2

Missouri River (mainstem) from Fort Peck Dam to the Milk River . . . . . B-D_2

"Pesticide" means insecticides, herbicides, rodenticides, fungicides or any substance or mixture of substances intended for preventing, destroying, controlling, repelling, altering life processes, or mitigating any insects, rodents, nematodes, fungi, weeds and other forms of plant or animal life.

"Residue" means oils, floating solids and sludge deposits.

"Sediment" means solid material settled from suspension in a liquid; mineral or organic solid material that is being transported or has been moved from its site of origin by air, water or ice and has come to rest on the earth's surface, either above or below sea level; or inorganic or organic particles originating from weathering, chemical precipitation or biological activity.

"Settleable solids" means inorganic or organic particles that are being transported or have been transported by water from the site or sites of origin and are settled or are capable of being settled from suspension.

"Sewer" means a pipe or conduit that carries wastewater or drainage water.

"State waters" means any body of water, irrigation system or drainage system, either surface or underground. This section shall not apply to irrigation waters where the waters are used up within the irrigation system and said waters are not returned to any other state waters. The term "state waters" as used in this rule does not include underground water.

"Storm sewer" or "storm drain" means a sewer that carries storm water and surface water, street wash and other wash waters, or drainage but excludes sewage and industrial wastes.

"True color" means the color of water from which the turbidity has been removed.

"Turbidity" means a condition in water or wastewater caused by the presence of suspended matter resulting in the scattering and absorption of light rays.

(4) Water-use classifications.

MISSOURI BASIN

Missouri River Drainage

Missouri River (mainstem) from Sun River to Rainbow Dam . . . . B-D_2

Missouri River drainage from Rainbow Dam in Great Falls to the North Dakota state line except the portion of the mainstem and the tributaries listed below . . . . . B-D_3

Teton River drainage to and including Deep Creek near Choteau . . . . . B-D_1

Remainder of Teton River drainage . . . . . B-D_2

Eagle Creek drainage to but excluding Dog Creek . . . . . B-D_1

Remainder of Eagle Creek drainage . . . . . B-D_3

Judith River drainage to Big Spring Creek . . . . . B-D_1

Big Spring Creek drainage to the Mill Ditch headgate near the southern city limits of Lewistown . . . . . B-D_1

Big Spring Creek (mainstem) from the Mill Ditch headgate to the Judith River . . . . . B-D_2

Tributaries to Big Spring Creek from the Mill Ditch headgate to the Judith River . . . . . B-D_1

Judith River (mainstem) from Big Spring Creek to the Missouri River . . . . . B-D_2

Tributaries to the Judith River from Big Spring Creek to the Missouri River . . . . . B-D_1

Cow Creek drainage to but excluding Al's Creek . . . . . B-D_1

Remainder of Cow Creek drainage . . . . . B-D_3

Musselshell River drainage to and including Hopley Creek near Harlowton . . . . . B-D_1

Musselshell River drainage from Hopley Creek to but excluding Half Breed Creek near Roundup except American Fork listed below . . . . . B-D_2

American Fork drainage . . . . . B-D_1

Musselshell River drainage from and including Half Breed Creek to Fort Peck Reservoir except Flatwillow Creek drainage listed below . . . . . B-D_3

Flatwillow Creek drainage (may be the Box Elder Creek drainage) near Mosby . . . . . B-D_2

Missouri River (mainstem) from Fort Peck Dam to the Milk River . . . . . B-D_2

(5) Water-use description and specific water quality criteria.

(a) General. Specific water quality criteria, along with criteria in section (6) protect the beneficial water uses set forth in the water-use descriptions for the following classifications of water. Criteria for organisms of the coliform group are based on a minimum of five samples obtained during separate 24-hour periods during any consecutive 30-day period analyzed by the most probable number or equivalent membrane filter methods. The metal limits on the Clark Fork River [section (6)] are to govern when this section (5) imposes a conflicting requirement with that criteria.

(b) A-Closed classification.

(i) Water-use description. Water supply for drinking, culinary and food processing purposes suitable for use after simple disinfection. Public access and activities such as livestock grazing and timber harvest are to be controlled by the utility owner under conditions prescribed and orders issued by the department. Only those waters on which access is presently controlled by the utility owner have been classified as A-Closed. If other uses are permitted, the waters are to be reclassified A-Open-D_1.

(ii) Specific water quality criteria.

(aa) The average number of organisms in the coliform group is not to exceed 50 per 100 milliliters.

(ab) Dissolved oxygen criteria are not applicable for the classification.

(ac) No change from natural pH is allowed.

(ad) No increase above naturally occurring turbidity is allowed.

(ae) No increase above naturally occurring water temperature is allowed.

(af) No increases above naturally occurring concentrations of sediment, settleable solids or residues, which adversely affect the use indicated, are allowed.

(ag) No increases of toxic or other deleterious substances, pesticides and organic and inorganic materials including heavy metals, above naturally occurring concentrations, are allowed.

(ah) No wastes are allowed which increase radioactivity above natural background levels.

(c) A-Open-D_1 classification.

(i) Water-use description. Water supply for drinking, culinary and food processing purposes suitable for use after simple disinfection and removal of naturally present impurities. Water quality is to be maintained suitable for bathing, swimming and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply. Where the waters are used for swimming or other water-contact sports, analyses are to be made by the utility owner and the department to determine if a higher degree of treatment is required for potable water use.

Waters, if shown to meet the A-Closed criteria, may be so classified by the department at the request of the utility owner. State waters within the boundaries of national parks and nationally designated wild, wilderness or primitive areas in the state are classified A-Open-D_1 except those adjacent to developed areas such as Snyder Creek through the community of Lake McDonald and Swiftcurrent Creek below the Many Glacier Chalet, both in Glacier National Park. Also, Georgetown, Flathead and Whitefish lakes and Lake Mary Ronan are classified A-Open-D_1 as are some streams presently used for domestic water supply.

(ii) Specific water quality criteria.

(aa) The average number of organisms in the coliform group is not to exceed 50 per 100 milliliters where demonstrated to be the result of domestic sewage.

(ab) Dissolved oxygen concentration is not to be reduced below 7.0 milligrams per liter.

(ac) Induced variation of hydrogen ion concentration (pH) within the range of 6.5 to 8.5 is to be less than 0.5 pH unit. Natural pH outside this range is to be maintained without change. Natural pH above 7.0 is to be maintained above 7.0.

(ad) No increase above naturally occurring turbidity is allowed.

(ae) A 1° F maximum increase above naturally occurring water temperature is allowed within the range of 32° F to 66° F; within the naturally occurring range of 66° F to 66.5° F, no discharge is allowed which will cause the water temperature to exceed 67° F; and where the naturally occurring water temperature is 66.5° F or greater, the maximum allowable increase in water temperature is 0.5° F. A 2° F per hour maximum decrease below naturally occurring water temperature is allowed when the water temperature is above 55° F, and a 2° F maximum decrease below naturally occurring water temperature is allowed within the range of 55° F to 32° F.

(af) No increases above naturally occurring concentrations of sediment, settleable solids or residues, which adversely affect the use indicated, are allowed.

(ag) Concentrations of toxic or other deleterious substances, pesticides and organic and inorganic materials including heavy metals, after treatment for domestic use, are not to exceed the recommended limits established in the 1962 U. S. Public Health Service Drinking Water Standards or subsequent editions; an increase of more than 10 percent of the concentration present in the receiving water is not allowed; maximum allowable concentrations are to be less than acute or chronic problem levels as revealed by bioassay or other methods.

(ah) True color is not to be increased more than two units above naturally occurring color.

(d) B-D1 classification.

(i) Water-use description. The quality is to be maintained suitable for drinking, culinary and food processing purposes after adequate treatment equal to coagulation, sedimentation, filtration, disinfection and any additional treatment necessary to remove naturally present impurities; bathing, swimming and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.

(ii) Specific water quality criteria.

(aa) The average number of organisms in the fecal coliform group is not to exceed 200 per 100 milliliters, nor are 10 percent of the total samples during any 30-day period to exceed 400 fecal coliforms per 100 milliliters. The average number of organisms in the coliform group is not to exceed 1,000 per 100 milliliters, nor are 20 percent of the samples to exceed 1,000 coliforms per 100 milliliters during any 30-day period.

(ab) Dissolved oxygen concentration is not to be reduced below 7.0 milligrams per liter.

(ac) Induced variation of hydrogen ion concentration (pH) within the range of 6.5 to 8.5 is to be less than 0.5 pH unit. Natural pH outside this range is to be maintained without change. Natural pH above 7.0 is to be maintained above 7.0.

(ad) The maximum allowable increase above naturally occurring turbidity is 5 Jackson Candle Units except as is permitted in the general water quality criteria.

(ae) A 1° F maximum increase above naturally occurring water temperature is allowed within the range of 32° F to 66° F; within the naturally occurring range of 66° F to 66.5° F, no discharge is allowed which will cause the water temperature to exceed 67° F; and where the naturally occurring water temperature is 66.5° F or greater, the maximum allowable increase in water temperature is 0.5° F. A 2° F per hour maximum decrease below naturally occurring water temperature is allowed when the water temperature is above 55° F, and a 2° F maximum decrease below naturally occurring water temperature is allowed within the range of 55° F to 32° F.

This applies to all waters in the state classified B-D_1 except for Prickly Pear Creek from McClellan Creek to the Montana Highway No. 433 crossing where a 2° F maximum increase above naturally occurring water temperature is allowed within the range of 32° F to 65° F; within the naturally occurring range of 65° F to 66.5° F, no discharge is allowed which will cause the water temperature to exceed 67° F; and where the naturally occurring water temperature is 66.5° F or greater, the maximum allowable increase in water temperature is 0.5° F.

(af) No increases above naturally occurring concentrations of sediment, settleable solids or residues, which adversely affect the use indicated, are allowed.

(ag) Concentrations of toxic or other deleterious substances, pesticides and organic and inorganic materials including heavy metals, after treatment for domestic use, are not to exceed the recommended limits contained in the 1962 U. S. Public Health Service Drinking Water Standards or subsequent editions; also, maximum allowable concentrations are to be less than acute or chronic problem levels as revealed by bioassay or other methods.

(ah) True color is not to be increased more than five units above naturally occurring color.

(e) <u>B-D_2 classification</u>.

(i) Water-use description. The quality is to be maintained suitable for drinking, culinary and food processing purposes after adequate treatment equal to coagulation, sedimentation, filtration, disinfection and any additional treatment necessary to remove naturally present impurities; bathing, swimming and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.

(ii) Specific water quality criteria.

(aa) The average number of organisms in the fecal coliform group is not to exceed 200 per 100 milliliters nor are 10 percent of the total samples during any 30-day period to exceed 400 fecal coliforms per 100 milliliters. The average number of organisms in the coliform group is not to exceed 1,000 per 100 milliliters nor are 20 percent of the samples to exceed 1,000 coliforms per 100 milliliters during any 30-day period.

(ab) Dissolved oxygen concentration is not to be reduced below 7.0 milligrams per liter from October 1 through June 1 nor below 6.0 milligrams per liter from June 2 through September 30.

(ac) Induced variation of hydrogen ion concentration (pH) within the range of 6.5 to 9.0 is to be less than 0.5 pH unit. Natural pH outside this range is to be maintained without change. Natural pH above 7.0 is to be maintained above 7.0.

(ad) The maximum allowable increase above naturally occurring turbidity is 10 Jackson Candle Units, except as is permitted in the general water quality criteria.

(ae) A 1° F maximum increase above naturally occurring water temperature is allowed within the range of 32° F to 66° F; within the naturally occurring range of 66° F to 66.5° F, no discharge is allowed which will cause the water temperature to exceed 67° F; and where the naturally occurring water temperature is 66.5° F or greater, the maximum allowable increase in water temperature is 0.5° F. A 2° F per hour maximum decrease below naturally occurring water temperature is allowed when the water temperature is above 55° F, and a 2° F maximum decrease below naturally occurring water temperature is allowed within the range of 55° F to 32° F.

(af) No increases above naturally occurring concentrations of sediment, settleable solids or residues, which adversely affect the use indicated, are allowed.

(ag) Concentrations of toxic or other deleterious substances, pesticides and organic and inorganic materials including heavy metals, after treatment for domestic use, are not to exceed the recommended limits contained in the 1962 U. S. Public Health Service Drinking Water Standards or subsequent editions; also, maximum allowable concentrations are to be less than acute or chronic problem levels as revealed by bioassay or other methods.

(ah) True color is not to be increased more than five units above naturally occurring color.

(f) <u>B-D3 classification.</u>

(i) Water-use description. The quality is to be maintained suitable for drinking, culinary and food processing purposes after adequate treatment equal to coagulation, sedimentation, filtration, disinfection and any additional treatment necessary to remove naturally present impurities; bathing, swimming and recreation; growth and propagation of non-salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.

(ii) Specific water quality criteria.

(aa) The average number of organisms in the fecal coliform group is not to exceed 200 per 100 milliliters nor are 10 percent of the total samples during any 30-day period to exceed 400 fecal coliforms per 100 milliliters. The average number of organisms in the coliform group is not to exceed 1,000 per 100 milliliters nor are 20 percent of the samples to exceed 1,000 coliforms per 100 milliliters during any 30-day period.

(ab) Dissolved oxygen concentration is not to be reduced below 5.0 milligrams per liter.

(ac) Induced variation of hydrogen ion concentration (pH) within the range of 6.5 to 9.0 is to be less than 0.5 pH unit. Natural pH outside this range is to be maintained without change. Natural pH above 7.0 shall be maintained above 7.0.

(ad) The maximum allowable increase above naturally occurring turbidity is 10 Jackson Candle Units, except as is permitted in the general water quality criteria.

(ae) A 3° F maximum increase above naturally occurring water temperature is allowed within the range of 32° F to 77° F; within the naturally occurring range of 77° F to 79.5° F, no thermal discharge is allowed which will cause the water temperature to exceed 80° F; and where the naturally occurring water temperature is 79.5° F or greater, the maximum allowable increase in water temperature is 0.5° F. A 2° F per hour maximum decrease below naturally occurring water temperature is allowed when the water temperature is above 55° F, and a 2° F maximum decrease below naturally occurring water temperature is allowed within the range of 55° F to 32° F.

This applies to all waters in the state classified B-D3, except from the Billings water supply intake to the water diversion at Intake, a 3° F maximum increase above naturally occurring water temperature is allowed within the range of 32° F to 79° F; within the range of 79° F to 81.5° F, no thermal discharge is allowed which will cause the water temperature to exceed 82° F; and where the naturally occurring water temperature is 81.5° F or greater, the maximum allowable increase in water temperature is 0.5° F.

From the water diversion at Intake to the North Dakota state line, a 3° F maximum increase above naturally occurring water temperature is allowed within the range of 32° F to 82° F; within the range of 82° F to 84.5° F, no thermal discharge is allowed which will cause the water temperature to exceed 85° F; and where the naturally occurring water temperature is 84.5° F or greater, the maximum allowable increase in water temperature is 0.5° F.

(af) No increases above naturally occurring concentrations of sediment, settleable solids or residues, which adversely affect the use indicated, are allowed.

(ag) Concentrations of toxic or other deleterious substances, pesticides and organic and inorganic materials including heavy metals, after treatment for domestic use, are not to exceed the recommended limits contained in the 1962 U. S. Public Health Service Drinking Water Standards or subsequent editions; also, maximum allowable concentrations are to be less than acute or chronic problem levels as revealed by bioassay or other methods.

(ah) True color is not to be increased more than five units above naturally occurring color.

(6) General water quality criteria.

(a) The degree of waste treatment required to restore and maintain the standards is to be determined by the department and is to be based on the following.

(i) The state's policy of nondegradation of existing high water quality as described in Section 69-4808.2, R.C.M. 1947.

(ii) Present and anticipated beneficial uses of the receiving water.

(iii) The quality and nature of flow of the receiving water.

(iv) The quantity and quality of the sewage, industrial waste or other waste to be treated.

(v) The presence or absence of other sources of pollution on the same watershed.

(b) Sewage is to receive a minimum of secondary treatment as defined by EPA in accordance with requirements as set forth in the Federal Water Pollution Control Act Amendments of 1972.

(c) Industrial waste is to receive, as a minimum, treatment equivalent to the best practicable control technology currently available (BPCT) as defined by EPA. In cases where BPCT is not defined by EPA, industrial waste is to receive, after maximum practicable in-plant control, a minimum of secondary treatment or equivalent.

(d) For design of disposal systems, stream flow dilution requirements are to be based on minimum consecutive seven-day average flow which may be

expected to occur on the average of once in ten years. When dilution flows are less than the above design flow at a point discharge, the discharge is to be governed by the permit conditions developed for the discharge through the waste discharge permit program.

(e) State surface waters are to be free from substances attributable to municipal, industrial, agricultural practices or other discharges that will:

(i) Settle to form objectionable sludge deposits or emulsions beneath the surface of the water or upon adjoining shorelines.

(ii) Create floating debris, scum, a visible oil film (or be present in concentrations at or in excess of 10 milligrams per liter) or globules of grease or other floating materials.

(iii) Produce odors, colors or other conditions as to create a nuisance or render undesirable tastes to fish flesh or make fish inedible.

(iv) Create concentrations or combinations of materials which are toxic or harmful to human, animal, plant or aquatic life.

(v) Create conditions which produce undesirable aquatic life.

(f) No wastes are to be discharged and no activities conducted such that the wastes or activities, either alone or in combination with other wastes or activities, will violate, or can reasonably be expected to violate, any of the standards; (e.g., in a reach of stream classified B-D$_1$, the total allowable cumulative increase to naturally occurring turbidity conditions in the reach is 5 Jackson Candle Units).

(g) No wastes are to be discharged and no activities conducted which, either alone or in combination with other wastes or activities, will cause turbidities to exceed those allowed by specific water quality criteria; provided, short-term activities necessary to accommodate essential dredging, channel or bank alterations, stream diversions or other construction where turbidities in excess of the criteria are unavoidable, may be authorized by the department under conditions as it may prescribe.

(h) Methods of sample collection, preservation and analysis used to determine compliance with the standards are to be in accordance with the latest edition of Standard Methods for the Examination of Water and Wastewater published by the American Public Health Association or in accordance with tests or procedures that have been found to be equally or more applicable.

(i) For operations of existing water impoundments that cause conditions harmful to prescribed beneficial uses of state waters, it is to be

demonstrated to the satisfaction of the department that continued operations will be done in the best practicable manner to minimize harmful effects and will not violate state laws or department rules. New water impoundments shall be designed to provide temperature variations in discharging water that maintain or enhance the existing propagating fishery and associated aquatic life. As a guide, the following temperature variations are recommended: Continuously less than 40° F during the months of January and February, and continuously greater than 44° F during the months of June through September.

(j) Ponds for waste treatment purposes are not to be located in drainage ways where the volume of drainage water from a 10-year storm entering the ponds exceeds one-half the volume of the pond; provided that, subject to approval by the department as to design and maintenance, ponds located in drainage ways for the express purpose of containing emergency oil spills are permitted.

(k) Dumping of snow from municipal and/or parking lot snow removal activities into waters of the state is prohibited without a permit from the department.

(l) Existing discharges to state waters will be entitled a mixing zone as determined by the department.

(m) Until such time as minimum stream flows are established for dewatered streams, the minimum treatment requirements for discharges to dewatered receiving streams are to be no less than the minimum treatment requirements prescribed.

(n) Treatment requirements for discharges to intermittent streams are to be no less than the minimum treatment requirements prescribed.

(o) Pollution resulting from storm drainage, storm sewer discharges, and non-point sources, including irrigation practices, road building, construction, logging practices, overgrazing and other practices, are to be eliminated or minimized as ordered by the department.

(p) Application of pesticides in or adjacent to state waters is to be in compliance with the labeled direction, and in accordance with provisions of the Montana Pesticides Act (Title 27, Chapter 2, R.C.M. 1947) and the Federal Environmental Pesticides Control Act (Public Law 92-516). Excess pesticides and pesticide containers are not to be disposed of in a manner or in a location where they are likely to pollute state waters.

(q) The following radiological criteria shall apply to all waters except those classified as A-Closed:

(i) The average dissolved concentrations (including the naturally occurring or background contribution) of iodine 131, radium-226, strontium-89, strontium-90 and tritium are not to exceed the following concentration limits:

Iodine-131	5 pCi/L
Radium-226	1 pCi/L
Strontium-89	100 pCi/L
Strontium-90	10 pCi/L
Tritium	3,000 pCi/L

For all other radionuclides, the average dissolved concentration limits are to be 1/150 of the corresponding maximum permissible concentration in water for continuous occupational exposure as recommended by the National Committee on Radiation Protection (National Bureau of Standards Handbook 69 or subsequent revisions.)

(ii) For a mixture of radionuclides, the following relationship is to be satisfied:

$$\frac{C_1}{L_1} + \frac{C_2}{L_2} \ldots + \frac{C_n}{L_n} \leq 1.00$$

C denotes the average concentration of the respective radionuclide, and L denotes its concentration limit.

(iii) Where alpha emitters, strontium-90, radium-228, iodine-129, iodine-130 and lead-210 are known to be absent, routine analyses for dissolved gross beta radioactivity (excluding potassium-40 contribution) may be employed to monitor and show compliance with this criterion (except for tritium) as long as the gross concentration does not exceed 100 pCi/L. When these conditions are not met, routine quantitative analyses of individual radionuclides are to be performed to show compliance. Except in cases where tritium from other than natural sources is known to be absent, routine tritium analyses are to be performed to show compliance. (Note: "Absence" means a negligibly small fraction of the specific concentration limit, where the limit for unidentified alpha emitters is taken as the limit for radium-226.)

(iv) For radionuclides associated with suspended material in transport, the average concentration limits are to be 1/150 of the corresponding maximum permissible concentration in water (insoluble form) for continuous occupational exposure as recommended by the National Committee on Radiation Protection. In-stream sedimentation of these materials is not to produce solids beds that are not in compliance with subsections (q) (i) and (q) (ii) (because of leaching) and/or excessive accumulation in native flora and fauna.

(v) Average concentrations are to be computed from monitoring data acquired during the previous 12 months; maximum concentrations are not to exceed three times the average concentration limits specified.

(vi) Variances from concentration limits specified will be permitted only if the contributing source is non-controllable or a natural source. Best available treatment must be provided for man-made discharges, and the exposure received by affected population groups must be within established dose limits.

(r) No wastes are to be discharged and no activities conducted which, either alone or in combination with other wastes or activities, will result in the dissolved gas content relative to the water surface to exceed 110 percent of saturation.

(s) Bioassay median tolerance concentrations are to be based on latest available research results for the materials, by bioassay tests procedures for simulating actual stream conditions as set forth in the latest edition of Standard Methods for the Examination of Water and Wastewater published by the American Public Health Association, or in accordance with tests or analytical procedures that have been found to be equal or more applicable by EPA. Bioassay studies are to be made using the most sensitive local species and life stages of economic or ecological importance; provided other species whose relative sensitivity is known may be used when there is difficulty in providing the most sensitive species in sufficient numbers.

When specific application factors are not available, the factor is to be determined by using methods listed in Water Quality Criteria published by the Federal Water Pollution Control Administration (1968), or by using other methods accepted as equal or applicable by EPA.

(t) Metal limits for the Clark Fork River (mainstem) from the confluence of Warm Springs Creek to the confluence with Cottonwood Creek are:

Material	Average Daily Concentration ug/l	Maximum Instantaneous Concentration ug/l
Total copper	90	180
Dissolved copper	30	40
Total zinc	300	1,000
Dissolved zinc	80	140
Total iron	1,300	2,200
Dissolved iron	150	160
Total lead	100	100
Dissolved lead	100	100
Total cadmium	10	10
Total arsenic	10	16
Total mercury	1	1

Metal limits for Clark Fork River (mainstem) from the confluence of Cottonwood Creek to the Idaho state line are:

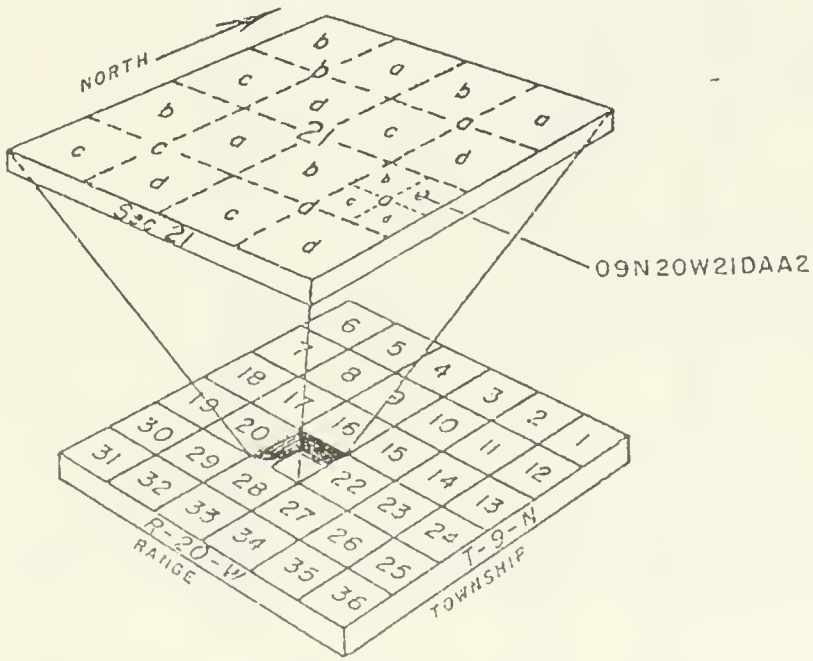
Material	Average Daily Concentration ug/l	Maximum Instantaneous Concentration ug/l
Total copper	50	90
Dissolved copper	30	30
Total zinc	100	200
Dissolved zinc	70	80
Total iron	300	1,300
Dissolved iron	150	150
Total lead	50	50
Dissolved lead	50	50
Total cadmium	10	10
Total arsenic	10	10
Total mercury	1	1

(History: Sec. 69-4814, R.C.M. 1947; IMP Sec. 69-4808.2(1)(b), R.C.M. 1947; Order MAC No. 16-1; Adp. 12/31/72; Eff. 12/31/72; AMD, MAC Notice No. 16-2-3, Order MAC No. 16-2-5; Adp. 7/13/73; Eff. 11/4/73; PRIOR p. 16-375; AMD, MAC Notice No. 16-2-31; Order MAC No. 16-2-11; Adp. 7/19/74; Eff. 9/5/74; PRIOR p. 16-387, 391, 393, 393.1, 393.4.).

APPENDIX C

SYSTEM FOR GEOGRAPHIC LOCATION OF FEATURES

Wells, springs, water-sampling locations, and stream-gaging locations are assigned numbers based on the system of land subdivision used by the U. S. Bureau of Land Management. The number consists of twelve characters and describes the location by township, range, section, and position within the section. The figure below illustrates the numbering method. The first three characters of the number give the township, the next three characters the range. The next two numbers give the section number within the township, and the next three letters describe the location within the quarter section (160-acre tract) and the quarter-quarter section (40-acre tract), and the quarter-quarter-quarter section (10-acre tract). These subdivisions of the 640-acre section are designated a, b, c, and d in a counterclockwise direction, beginning in the northeast quadrant. If there is more than one feature in a 10-acre tract, consecutive digits beginning with 2 are added to the number. For example, if a water-quality sample was collected in sec.21,T.9N.,R20W, it would be numbered 09N20W21DAA2. The letters DAA indicate that the well is in the NE¼ of the NE¼ of the SE¼, and the number 2 following the letters DAA indicates there is more than one water-quality sampling location in this 10-acre tract.



APPENDIX D

STATEWIDE PRIORITY LIST FOR CONSTRUCTION GRANTS PROGRAM

Community	Stream Segment	Water Use	Population Served	Scope of Project	Phase Construction	Total Points
Three Forks	6	6	2	30		94*
Whitefish (Birch Point)	8	6	2	15		81*
Missoula	8	6	3	30	30	77
Three Forks	6	6	2	30	30	74
Flaxville	6	2	1	15		74*
Great Falls	4	4	3	30	30	71
Victor	6	6	1	40		53
Miles City	6	2	2	40		50
Poplar	6	2	2	40		50
Billings Sixth Ave. No. Int.	4	2	3	40		49
Glasgow	4	2	2	40		48
Whitefish	8	6	2	30		46
Gallatin Co. RID 305	8	6	2	30		46
Bozeman	8	4	3	30		45
Bigfork	8	6	1	30		45
Livingston	6	6	2	30		44
Dillon	6	6	2	30		44
Libby	6	6	2	30		44
Hamilton	6	6	2	30		44
Red Lodge	6	6	2	30		44
Townsend	6	6	2	30		44
Thompson Falls	6	6	2	30		44
Boulder	6	6	2	30		44
Eureka	6	6	2	30		44
Columbus	6	6	2	30		44
Whitehall	6	6	2	30		44
Butte	8	2	3	30		43
Stevensville	6	6	1	30		43
Manhattan	6	6	1	30		43
Lodge Grass	6	6	1	30		43

(1) Montana Water Pollution Control Program Plan, June 15, 1974.
*Projects certified but not funded during the fiscal year received additional 50 points.

APPENDIX E

Periphyton Analysis from Selected Sites in the Middle Missouri Basin.

I. Big Spring Creek North of Lewistown, Periphyton (rocks), 9/12/74.

Rhoicosphenia curvata, Cocconeis pediculus, C. placentula var. euglypta, Amphora ovalis var. pediculus, Navicula tripunctata, N. viridula, Cymbella affinis, C. ventricosa, Diatoma vulgare, Fragilaria construens var. venter, Cymbella sinuata, Nitzschia dissipata, Cymatopleura solea, Nitzschia acuta, Synedra ulna var. contracta, Gyrosigma acuminatum, Achnanthes minutissima, Navicula cryptocephala, N. c. var. veneta, Gomphonema olivaceum, Nitzschia amphibia, Achnanthes linearis, Cocconeis placentula var. lineata, Cyclotella sp., Cymbella microcephala, Surirella ovata, Achnanthes lanceolata, Surirella angustata, Gomphonema parvulum, Amphipleura pellucida, Nitzschia palea, Amphora ovalis, Gomphonema angustatum var. producta, Nitzschia sp., Pinnularia leptosoma, Gomphonema bohemicum, Nitzschia fonticola, Cyclotella meneghiniana, Navicula pupula, Fragilaria leptostauron, Nitzschia romana, Navicula minuscula, Nitzschia sigmoidea, Caloneis amphisbaena.

II. Cottonwood Creek near Lewistown, Periphyton, 10/16/74.

Ulothrix, Phormidium (2), Oscillatoria (1), Cymbella (4), Gomphonema, Achnanthes, Navicula, Nitzschia, Fragilaria, Cyclotella, Synedra (3), Pediastrum, Cosmarium, Gyrosigma, Stigeoclonium (5), Diatoma, Closterium, Mougeotia, Ankistrodesmus, Cymatopleura, Scenedesmus, Nematodes.

III. Warm Spring Creek @ Highway 235, Periphyton, 10/16/74.

Stigeoclonium, Cymbella (1), Gomphonema, Achnanthes, Navicula, Synedra (2), Nitzschia (3), Cocconeis, Diatoma (4), Fragilaria, Cymatopleura solea, Oscillatoria, Audouinella (5), Filamentous bluegreen.

IV. Arrow Creek @ Highway 230, Periphyton, 10/16/74.

Caloneis amphisbaena, Gyrosigma, Amphipleura pellucida, Synedra (1), Navicula (2), Surirella (5), Amphiprora alata (4), Gomphonema, Nitzschia (3), Achnanthes, Rhiocosphenia, Cyclotella, Cymbella, Diatoma, green coccoid, Rhopalodia, Calconeis.

V. Judith River Headwaters near Utica, Periphyton, 10/17/74.

Nitzschia (5), Cymbella (2), Synedra (3), Oscillatoria, Cyclotella (4), Cosmarium, Cocconeis, Denticula, Diatoma, Ankistrodesmus, Navicula, Achnanthes, Gomphonema, Rhoicosphenia, Mougeotia, Amphipleura pellucida, Caloneis amphisbaena, Spirulina, Fragilaria, Gyrosigma, Filamentous bacterium (1), Stauroneis smithii, Nematode.

VI. Judith River Middle Fork 3 miles South of Utica, Periphyton, 10/17/74.

Fragilaria (3), Oscillatoria (1), Cymbella (2), Synedra, Diatoma (5), Nitzschia, Achnanthes, Cyclotella (4), Cocconeis, Ankistrodesmus, Navicula, Amphipleura pellucida, green coccoid, Gomphonema, Stigeoclonium, Mougeotia, Cymatopleura solea, Calothrix, Caloneis or Pinnularia.

VII. Judith River between Hobson and Utica, Periphyton, 11/7/74.

Chara (1), Fragilaria (3), Synedra (2), Ulothrix, Cymbella (4), Diatoma (5), Cyclotella, Navicula, Achnanthes, Gomphonema, Nitzschia, Mougeotia, Gyrosigma, unidentified coccoid, Cymatopleura, Cocconeis.

VIII. Judith River at Highway 87, Periphyton, 10/16/74.

Oscillatoria (1), Denticula, Cymbella (2), Achnanthes, Synedra (3), Diatoma, Cyclotella, Zygnema, Navicula, Mougeotia, Cosmarium, Cocconeis, Scenedesmus, Closterium, Pediastrum, Eunotia, Gyrosigma, Bulbochaete, unidentified desmid.

IX. Judith River at Mouth near Highway 236, Periphyton, 11/7/74.

Cymbella (5), Navicula (3), Diatoma (1), Synedra (2), Nitzschia (4), Achnanthes, Scenedesmus, Gyrosigma, Caloneis amphisbaena.

X. Missouri River at P&N Ferry, Periphyton, 11/7/74.

Synedra (3), Navicula (2), Cocconeis, Gomphonema (4), Nitzschia (5), Denticula, Diatoma (1), Cymbella, Epithemia, Gyrosigma, Calconeis amphisbaena, Amphipleura, Surirella.

APPENDIX F
Table
Synopsis of Middle Missouri River Stations

STATION AND LOCATION	SUBSTRATE TYPE	BANK CONDITIONS
MISSOURI RIVER		
1) at Loma 09E 25N 18 CA	Gravel, rubble, boulders	Natural grasslands, erosion apparent, dry coulees
2) at Virgelle 11E 25N 24 AB	Gravel, rubble, boulders	Natural grasslands,natural erosion, dry coulees
3) upstream of Arrow Creek 14E 23N 31 DD	Gravel, rubble, boulders	Natural grasslands, erosion apparent, dry coulees
4) downstream of Judith River 23N 17E 27 BA	Silt, gravel, rubble, boulders	Natural grasslands, plateaus farmed, cultural caused erosion, dry coulees
5) at Fred Robinson Bridge Hwy 19 22N 23E 36 AB	Silt, gravel, rubble	Natural grasslands, dry coulees, eroding banks
DRAINAGES SAMPLED ON THE NORTH BANK OF THE MISSOURI RIVER		
1) Eagle Creek SE of Big Sandy 25N 13E 16 DC	Silt, sand, gravel	Drains badlands type terrain
2) Bullwacker Creek N of Baker Monument 23N 21 E 03 BB	Silt, sand	Drains badlands type terrain

Table
(continued)

STATION AND LOCATION	SUBSTRATE TYPE	BANK CONDITIONS
3) Cow Creek NE of Baker Monument 23N 22E 06 DA	Silt, gravel, sand	Drains badlands type terrain
DRAINAGES SAMPLED ON THE SOUTH BANK OF THE MISSOURI RIVER		
1) Arrow Creek W of P&N Ferry 22N 14E 32 CD	Silt, sand	Drains alluvial material, cultural activities, steep banks
2) Judith River at P&N Ferry 23N 16E 26 BD	Silt, gravel	Cultural activities, steep banks
3) Dog Creek E of P&N Ferry 23N 16E 25 BD	Silt, gravel, sand	Drains grassland and some cultural activities
4) Unnamed Coulee N of Two Calf Creek 22N 23E 17 AB	Silt	Grassland areas
5) Two Calf Creek W of Fred Robinson Bridge 22N 23E 28 AB	Silt, sand	Grassland areas, steep erodable banks
6) Big Dry Creek E of Jordan, Hwy 200 18N 40E 09 DB	Silt, sand	Grassland areas, cultural activities, in valley

Table
(continued)

STATION AND LOCATION	SUBSTRATE TYPE	BANK CONDITIONS
15) Judith River @ Hwy 235 near Danvers 18N 16E 32 CD	Gravel, rubble, silt	Agricultural activities, bank soil, rubble, gravel
16) Judith River near Hobson @ Hwy 87 14N 15E 06 AB	Gravel, rubble	Downstream of City Dump, agricultural activities, soil, gravel, rubble
17) Judith River between Hobson & Utica 14N 14E 10 BD	Gravel	Agricultural activities, soil, gravel, rubble
18) Judith River S of Utica 14N 13E 28	Silt, gravel, rubble	Agricultural activities, soil, gravel, rubble
19) Middle Fork Judith River.S of Utica 14N 12E 35 BD	Silt, gravel, rubble	Agricultural activities, soil, gravel, rubble

Table
(continued)

STATION AND LOCATION	SUBSTRATE TYPE	BANK CONDITIONS
JUDITH RIVER BASIN DRAINAGE		
1) Warm Spring Creek at Hwy 235 (also near Brooks) 17N 16E 17 AD	Rubble	Varies from grass, rock, irrigated fields
2) Ross Fork at Hwy 87 14N 15E 11 BA	Gravel, silt	Variable, grass fields, farmland, soil and rubble banks
3) Dry Wolf near Denton 18N 15E 33 BA	Silt, gravel	Wheatlands, grasslands, soil and rubble banks
4) Wolf Creek N of Stanford (also near Denton) 17N 12E 21 AD	Silt, gravel	Wheatlands, grasslands, soil and rubble banks
5) Cottonwood Creek W of Lewistown, Hwy 87 15N 17E 22 BA	Gravel	Wheatlands, grasslands, hay, soil & rubble banks
6) Beaver Creek W of Lewistown @ Hwy 87 15N 16E 11 AB	Gravel, silt	Wheatlands, grasslands, hay, soil & rubble banks

Table
(continued)

STATION AND LOCATION	SUBSTRATE TYPE	BANK CONDITIONS
7) Little Rock Creek W of Lewistown @ Hwy 87 14N 16E 11 AB	Gravel, silt	Wheatlands, grasslands, hay, soil & rubble banks
8) Coyote Creek N of Stanford 16N 12E 15 AB	Silt, gravel	Wheatlands, grasslands, hay, soil & gravel banks
9) Sage Creek near Danvers @ Hwy 235 18N 15E 31 DC	Gravel, silt	Wheatlands, grasslands, soil and gravel banks
10) Casino Creek at Lewistown 15N 18E 22 AA	Gravel, rubble	Urbanized soil, gravel, rubble
11) Big Spring Creek N of Lewistown 18E 17E 05 DA	Gravel, rubble, silt	Urbanized downstream of sewage plant, soil, gravel, rubble
12) Big Spring Creek S of Lewistown 15N 19E 31 AC	Rubble	Urbanized downstream of Fish Hatchery, bank soil, rubble
13) Boyd Creek E of Lewistown 15N 19E 18 AB	Silt, gravel	Soil gravel downstream of sawmill
14) Little Trout Creek S of Lewistown @ Hwy 191 13N 15E 01 DC	Silt, gravel, rubble	Agricultural activities, soil, rubble banks

APPENDIX G

Some Reservoirs Located in the Middle Misscuri River Basin (from Loma, MT, to Ft. Peck Dam).

NAME	WATER SOURCE	LOCATION	YEAR OF COMPLETION	CAPACITY ACRE FEET
Ackley Lake	Judith River offstream	14N 15E	1938	6,140
No. Winifred	Judith River	21N 16E 27	1936	334

Numerous other reservoirs exist in this basin, but none have a flow influence on the Missouri River. Ackley and No. Winifred are listed due to their probable flow influence on the Judith River.

Records from Montana Water Resources Board.

APPENDIX H

Middle Missouri Basin Irrigation Systems:

Drainage Basin	
41S	Judith River Ackley Lake Water Users Association
40E	Missouri River between Musselshell River and Fort Peck Dam Wiota Pump Unit (Ft. Peck project)

Miscellaneous diversions are located throughout this basin.

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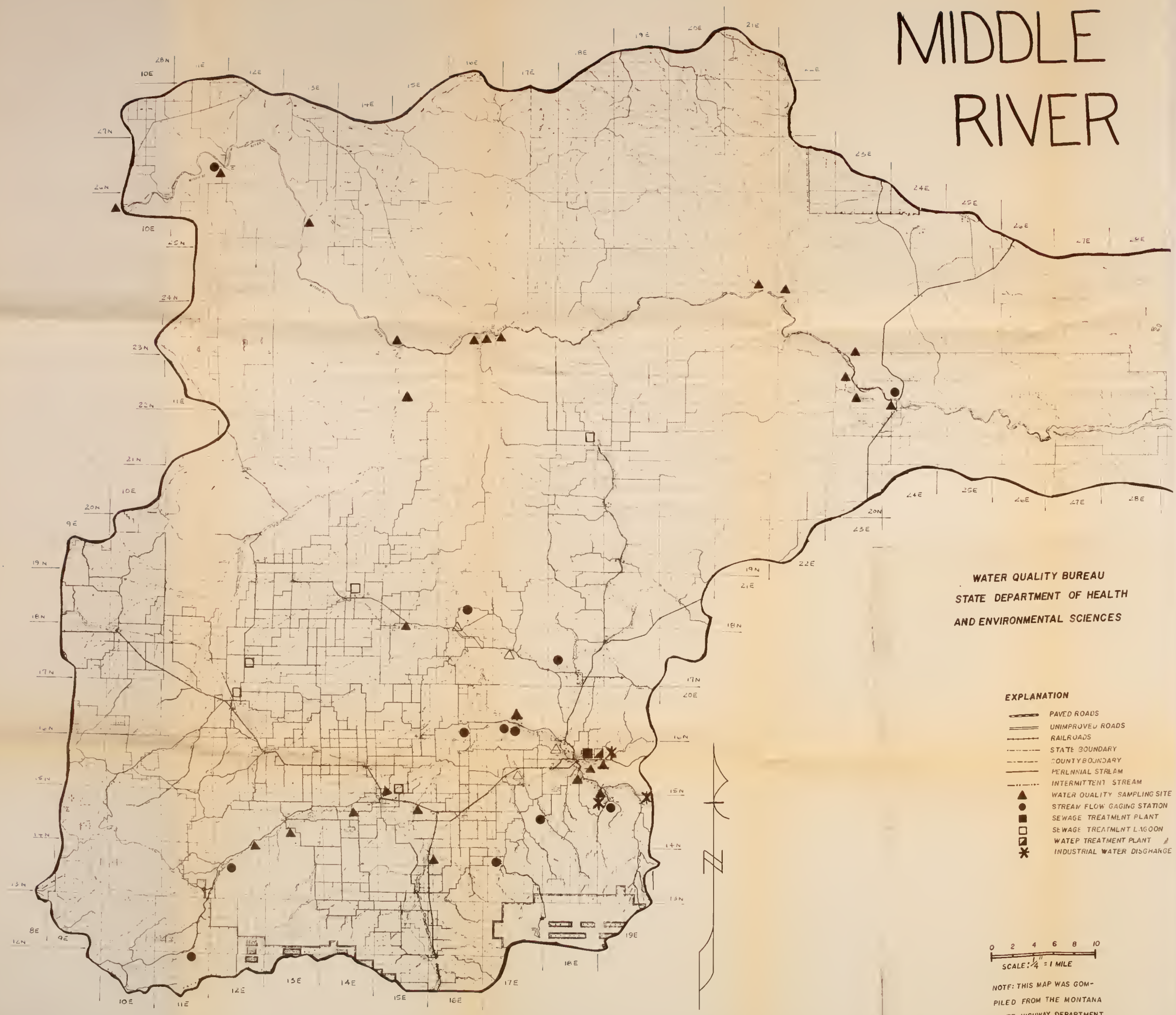
MIDDLE RIVER



MISSOURI BASIN

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